Great Lakes Water Authority

September 28, 2017

Preface

These Master Specifications and Standard Drawings are designed to be used in accordance with the User Guide, contract documents and drawings found electronically on the GREAT LAKES WATER AUTHORITY (GLWA) website, http://www.GLWA.org. The current, official version of the Master Specifications, any Supplemental Specifications, and all previous editions can also be found in electronic form on the website.

Printing of the Master Specifications from the website is allowed, however, Reproduction for non-GLWA uses is strictly prohibited. The electronic version is also fully searchable for utilization on GLWA projects.

GLWA Consultants, contractors and any other parties working on GLWA projects shall use the Master Specifications in conjunction with the GLWA User Guide and FormSpec. The Master Specifications are not designed to address all situations. The Master Specifications are intended to focus on standard applications for the design and construction of water, storm, and wastewater systems. GLWA Standard Drawings, schedules and other contract drawings can also be used to detail project specific information.

The Master Specifications should not be modified. Instead, Provisional Specifications should be created in accordance with the User Guide to address limitations, differing details, and additional, specialized specifications. GLWA may also provide—at the discretion of the Master Specifications Oversight Committee—Supplemental Specifications as modifications to the Master Specifications as found on the GLWA website. This allows the Master Specifications to be used by reference.

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DIVISION 1 – GENERAL REQUIREMENTS

SECTION 01010

ADMINISTRATIVE PROVISIONS

PART 1 - GENERAL

1.1 SCOPE. This section details general Contract Administrative Provisions applicable to all Work to be performed and is intended to be used in conjunction with all aspects of the Contract Documents. Even if not specifically stated, all work associated with Master Specification Sections, unless otherwise clarified or stated, shall also comply with Division 01 Master Specification Section references. Where conflicts develop in specification sections, the more stringent requirement shall govern.

This section includes the following Articles:

Contract Drawings.

Alternatives.

Allowances.

Coordination.

Control Surveys.

Property and Survey Monuments.

Cleanliness of the Work and Streets.

Regulatory Requirements.

Safety Precautions.

Licenses, Permits, and Inspections.

Additional Engineering Services.

Cooperation.

Protection of Property.

Fire Protection.

Chemicals.

Existing Utilities and Structures.

Alteration of Existing Water Mains and Services.

Easement and/or Right-of-Way Across Private Property.

Claims by One Contractor Arising from Alleged Damage by Another Contractor.

Historical Specimens.

Abbreviations.

References.

1.2 CONTRACT DRAWINGS. Resource drawings are available for the Contractor to use. Arrange with DWSD Document Control to receive copies of existing drawings within the limit of the Work. DWSD does not accept responsibility for the accuracy of the drawings.

1.3 ALTERNATIVES. Contract Drawings indicate the extent and general arrangement of the Work. If any departures from the Contract Drawings are deemed necessary by the Contractor to accommodate the material and equipment the Contractor proposes to furnish, details of such departures and reasons thereof shall be submitted as soon as is practicable to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer. Approved changes shall be made without additional cost to the Owner for this Work or related Work under other Contracts of the project. If a credit is involved, it shall be negotiated with the Owner.

The specific equipment proposed for use by each Contractor on the project may require changes in structures, auxiliary equipment, piping, electrical, mechanical, controls, materials, or other Work to provide a complete and satisfactory operating installation. The Contractor, with proposed changes, shall submit to the Engineer for approval, all necessary drawings and details showing such changes to verify conformance with the overall project, both structural and architectural requirements, and overall operating performance. The bid price shall include all costs in connection with the preparation of new drawings, details, and all changes to construction work to accommodate the proposed equipment, including increases in the costs of other contracts.

Reasonable costs incurred by DWSD as a result of requests for approval of changes in the design initiated by the Contractor, shall be subtracted from the Contract Price regardless of whether the request is denied, granted, or modified.

1.4 ALLOWANCES.

1.4.01 Scope. In General, Cash and Provisionary Allowances are to be incorporated in the Work as defined in the Article 4 of the General Conditions (Exhibit C) of the Agreement. Specifically defined Allowances to be incorporated are listed in the Bid form and described in Specification Section 01025 Article 1.4 UNIT PRICE AND ALLOWANCE ITEMS.

1.4.02 Cash and Provisionary Allowance. It is understood that the Contractor has included in the Contract Price all allowances so named in the Contract Documents.

1.4.03 Measurement and Payment. Measurement and payment for any cash allowance shall be in accordance with the provisions of Article 4.7 ALLOWANCES of the General Conditions (Exhibit C) of the Agreement.

Payment for the cost of any cash allowance shall be in accordance with the Schedule of Values and, if appropriate, in accordance with the change order.

Upon final payment, or other appropriate time, the Contract Price shall be adjusted as required and an appropriate Change Order(s) issued.

Any cash allowance monies remaining after completion of the Work will be credited to DWSD.

1.5 COORDINATION.

1.5.01 Contract Documents. The Work to be performed under a particular specification section is not necessarily restricted to that of any one particular trade. Any item mentioned under any heading must be supplied, even though it is not called for again under the heading for the respective Work.

1.5.02 Existing Facilities. The Contractor shall not disrupt existing facility operations unless otherwise allowed in the Contract Documents. The Contractor shall prepare a construction traffic ingress/egress plan that separates construction activity access from DWSD operations activity.

All proposed interruptions or tie-ins to existing facilities or utilities or other activities affecting the Department's operations shall be scheduled. If shutdown or partial shutdown of an existing utility is required, requests must be submitted for shutdown in writing to the Engineer at least 15 days in advance, unless otherwise specified. A request for shutdown is required for public utilities as well as private utilities.

The Contractor must cooperate with the Owner in scheduling construction activities to minimize any conflicts with the construction activities of other Contractors on the site, and to enable the Owner to maximize the utilization and the occupancy of the site for his normal, as well as special, maintenance and operation activities.

The Engineer shall approve the scheduling of all such activities.

1.6 CONTROL SURVEYS. The City, through the Engineer, will establish for the Contractor's use, suitable points, marks, and benches at such locations and intervals as the Engineer deems reasonably necessary to determine the general location, alignment, elevation, and grade of the Work. The Contractor shall not proceed until a timely request to the Engineer for these control surveys has been made.

Provide reasonable and necessary opportunities to place and remove alignment points, furnish such materials, and give such assistance including clearing and grubbing, as may be required by the Engineer for his survey operations. If it is found necessary to carry on those operations on Sundays, legal holidays, or at other times when the Contractor's Work is not in progress, the Contractor shall furnish all necessary service and assistance. No compensation will be paid for any of the work, materials, or delay occasioned by giving lines and grades, or making other necessary measurements, or inspections.

Carefully preserve all bench marks, reference points and stakes as established by the Engineer. In case of destruction, the City shall charge the Contractor for the resulting restoration expenses. The Contractor shall be responsible for any mistakes and delays that may be caused by their loss or disturbance.

From the control points, marks and benches established by the Engineer and from information shown on the Drawings, make all additional measurements, and establish such additional points, lines and grades necessary for performance of the Work.

The Contractor shall employ a competent Civil Engineer registered within the State of Michigan as a Professional Engineer or Professional Land Surveyor. The Contractor shall require said Engineer to establish all lines, elevations, and reference marks needed by the Contractor during the progress of the Work, and from time to time, verify such marks by instrument or other appropriate means.

The Engineer shall have the right, at any time, to determine the correctness and completeness of the measurements taken, or points, lines, and grades established by the Contractor. Unacceptable or incorrect construction resulting from errors in measurements, points, lines, or grades made or established by the Contractor shall be corrected or replaced by construction that is strictly in accordance with the Contract requirements at the Contractor's expense. While the Engineer may draw the Contractor's attention to errors or incompleteness in the Contractor's measurements, points, lines, or grades, no omission on the part of the Engineer to point out such errors or incompleteness shall give the Contractor any right to claims against the City or shall in any way relieve the Contractor of his responsibilities in accordance with the terms of this Contract.

The Contractor shall make, check, and be responsible for all measurements and dimensions necessary for the proper construction of, and the prevention of, errors in the Work.

All details of survey stations, bearings, or similar survey designations are applicable only for the location of work to be performed under this Contract. It is understood that the designations are only approximate. No changes of such designation caused by the developments of construction shall be made the basis of claims for payment other than provided for in the Contract.

1.7 PROPERTY AND SURVEY MONUMENTS. Before any monuments or stakes marking the boundaries of property along or near the Work are removed or disturbed, the Contractor shall notify the Engineer in sufficient time so that they can be properly located and reset.

All precautions shall be taken to avoid disturbance of permanent survey monuments of any governmental authority, and when any of these are disturbed or destroyed, the Contractor shall restore them to the satisfaction of such authority, and shall pay all costs incurred by such authority in connection therewith.

1.8 CLEANLINESS OF THE WORK AND STREETS. The Contractor shall control dust to meet the requirements of the jurisdictional authorities. Control measures shall include, but are not limited to, sprinkling, applying calcium chloride, wheel washing, street sweeping, street washing, and load covering.

Trucks hauling loose materials to or from the site shall be tightly covered and their loads shall be trimmed to prevent spillage on the public streets or roads. This requirement likewise applies to suppliers making deliveries to the site. The Contractor shall promptly clean streets, or roads, dirtied by any cause arising from the operations or that of the subcontractors or supplier(s). Should the Contractor fail to maintain proper street or road cleanliness, the Owner will take the necessary steps to perform such cleaning and will charge the Contractor for all costs accordingly.

1.9 REGULATORY REQUIREMENTS. The requirements of this Article shall be made a part of any sub-contracts entered into.

All rules, regulations, orders, and permits, of any governmental agency applicable to the Work under this Contract shall be met. It is the Contractor's responsibility to be informed of all applicable governmental rules, regulations, orders, and permits. The Contractor shall cooperate with the Engineer to promptly furnish any information required by such agencies.

Final payment will not be made under the terms of this Contract until written approval of the final conditions of the Work is obtained by the Contractor from all public authorities or agencies having jurisdiction over any portion of the Work included in the Contract.

1.10 SAFETY PRECAUTIONS. In addition to the Contractor’s responsibilities outlined in the General Conditions section, the Contractor shall be responsible for the following actions:

The Contractor shall comply with such safety regulations as may be prescribed by the Engineer, Owner, or local authorities having jurisdiction and shall, when so directed, properly correct any unsafe conditions created by, or unsafe practices on the part of, employees or subcontractors. In the event of the Contractor's failure to comply, the Engineer or Owner may take the necessary measures to correct the conditions or practices, and all costs thereof will be charged to the Contractor, and will be deducted from any monies due the Contractor. Failure of the Engineer to direct the correction of unsafe conditions or practices shall not relieve the Contractor of his responsibility hereunder.

The Contractor shall erect barriers, guard rails, screens, sheathing, bracing, covers, nets, shields, and false-work of non-combustible materials as determined by Engineer to keep a separation between the Contractor’s Work and the Owner’s operations, as needed for the safety of the Work and the Owner’s employees.

The Contractor shall provide adequate shielding to prevent high temperature particles and sparks (resulting from, but not limited to, welding, metal cutting, and grinding), other building debris, spilled sludge, or other materials (resulting form construction, operation, or maintenance activities) from falling upon or reaching workers, the Owner’s workers, or others within the area.

Where project involves confined spaces, Contractor shall take measures as necessary to fully protect employees working in confined spaces to include provision of any necessary protective equipment, forced ventilation, and testing in full compliance with Master Specification Section 01040, Control of Work.

Adequate ventilation shall be provided to keep any noxious fumes, smoke or dust away from the Contractor’s or Owner’s workers or others within the area.

1.11 LICENSES, PERMITS, AND INSPECTIONS. All necessary licenses and permits including the building permit required for the Work, shall be secured at no cost to the Owner. Permits issued by DWSD will be furnished without charge. Permits applied for by the DWSD are described in Article 4.0 of Section 00210, Information for Bidders

The Contractor shall obtain, keep current and pay all necessary fees for any necessary construction permits from those authorities, agencies or municipalities having jurisdiction over land areas, water areas, utilities, or structures which are located within the contract limits and which will be occupied, encountered, used, or temporarily interrupted by the Contractor's operations unless otherwise stated. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the Contractor's responsibility to familiarize himself and comply with such regulations or requirements as they apply to operations on this project. The Owner shall obtain all water tap permits from the City of Detroit, Water and Sewerage Department.

The Contractor shall apply for inspection of the Work to any and all local, state, or national authorities having jurisdiction, and shall deliver to the Engineer all required certificates of approval of such authorities.

All costs, including fees, inspection charges, temporary improvements and the restoration of existing improvements (e.g. sidewalks, pavements, soil erosion and sedimentation control, landscaping, etc.) shall be paid and provided to the satisfaction of the authority having jurisdiction and shall be included in the contract price.

1.12 ADDITIONAL ENGINEERING SERVICES. If the Engineer is required to provide additional engineering services as a result of substitution of materials or equipment submitted as "or equal" by the Contractor, or changes made by the Contractor in dimension, weight, and power requirements of the equipment and accessories furnished, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor for the Contractor’s convenience, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner and paid by the Contractor.

Structural design shown on the Contract Drawings is based on maximum weights for major items of equipment, as indicated on the Contract Drawings as specified. If the equipment furnished exceeds the weights of said equipment, the Contractor shall assume the responsibility for all costs of the redesign and for any construction changes required to accommodate the equipment furnished, including the Engineer's expense in connection therewith.

In the event that the Engineer is required to provide additional engineering services as a result of the Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Engineer is required to examine and evaluate any changes proposed by the Contractor solely for the convenience of the Contractor, then the Engineer's charges in connection with such additional services shall be charged to the Contractor by the Owner and paid by Contractor.

1.13 COOPERATION. The Contractor shall allow the Owner (or agents), and other project Contractors (or agents), to enter the work area for the purpose of constructing, operating, maintaining, removing, repairing, altering or replacing such pipes, sewers, conduits, manholes, wires, poles, or other structures and appliances as may be required. The Contractor shall cooperate with all the aforesaid parties and shall allow reasonable provisions for the prosecution of any other work by the

Owner, or others, to be done in connection with Work, or in connection with the normal use of the facilities.

Each Contractor shall cooperate fully with the Owner, the Engineer, and all other Contractors employed in the Work, to effect proper coordination and progress to complete the project on schedule and in proper sequence. Insofar as possible, decisions of all kinds required from the Engineer shall be anticipated by the Contractor to provide ample time for inspection, or the preparation of instructions.

Each Contractor shall assume full responsibility for the coordination and integration of all parts of his Work with that of other Contractors. Each Contractor's Superintendent shall coordinate all Work with other Contractors. Each Contractor shall layout his own Work in accordance with the Contract Drawings, specifications and instructions of the latest issue, and with due regard to the Work of other Contractors.

Periodic coordinating conferences shall be held per the section on Project Meetings of the Contract Documents.

1.14 PROTECTION OF PROPERTY. In the event of any claims for damage or alleged damage to property as a result of Work under this Contract, the Contractor shall be responsible for all costs in connection with the settlement of or defense against, such claims. Prior to the commencement of Work in the vicinity of property adjacent to the Work site, the Contractor, at his own expense, shall take such surveys as may be necessary to establish the existing condition of the property.

Before final payment can be made, the Contractor shall furnish satisfactory evidence that all claims for damages have been legally settled or sufficient funds to cover such claims have been placed in escrow, or that an adequate bond to cover such claims has been obtained to secure payment with interest.

In the event that any Contractor has trespassed upon private property in the prosecution of the Work of this contract, the Owner may withhold payment for the value of such Work in or on the property, but in any case no less than a sum of $500.00 for each property trespassed, until the Contractor has secured a release from the property owner upon whose property the trespass was committed.

Contractor shall be responsible for the protection of his own storage area.

1.15 FIRE PROTECTION. All Contractors shall take all necessary precautions to prevent fires, and shall provide adequate equipment for extinguishing fires. No burning of trash or debris will be permitted.

When fire or explosive hazards are created in the vicinity of the Work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the Contractor shall immediately alert the local Fire Marshal, the Engineer, and the Owner. The

Contractor shall exercise all safety precautions, and shall comply with all instructions issued by the Fire Marshal and will cooperate with the Owner to prevent the occurrence of a fire or an explosion.

1.16 CHEMICALS. All chemicals used during the construction or furnished for the project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of the EPA, USDA or both. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable law, rules, and regulations. All chemicals, and the use of chemicals, shall comply with the City of Detroit, "Right to Know Rules" and the DWSD Safety Office.

1.17 EXISTING UTILITIES AND STRUCTURES. The term existing utilities shall be deemed to refer to publicly-owned and privately-owned utilities such as electric power, reservoirs, conduits, and lighting, telephone, water, gas, drains, storm drains, process lines, sanitary sewers, raceway, and all appurtenant structures.

Where existing utilities and structures are indicated on the Contract Drawings, it shall be understood that all of the existing utilities and structures affecting the work may not be shown, and that the locations of those shown are approximate only. It shall be the responsibility of the Contractor to ascertain the actual extent and exact location of existing utilities and structures. In every instance, the Contractor shall notify the proper authority having jurisdiction and obtain all necessary directions and approvals before performing any Work in the vicinity of existing utilities.

Prior to beginning any excavation Work, the Contractor shall, through field investigations, determine any conflicts between existing utilities and new utilities, or other Work to be constructed under this project. This determination shall be based on the actual locations, elevations and slopes, of existing utilities as determined in the field investigations, locations, elevation, and slope of new utilities, if any, as shown on the Contract Drawings. If an interference exists, the Contractor shall bring it to the attention of the Engineer as soon as possible. If the Engineer agrees that an interference exists, he shall modify the design as required, including relocating existing utilities. The Contractor shall make arrangements with the respective utility Owners for the relocation of the utilities. Additional costs to the Contractor for this change shall be processed through a change order as detailed elsewhere in the Contract Documents. In the event the Contractor fails to bring a potential conflict or interference to the attention of the Engineer prior to beginning excavation work, the conflict or interference shall be corrected by the Contractor, as directed by the Engineer, at no additional expense to the Owner.

The Work shall be carried out in a manner to prevent disruption of existing services and to avoid damage to the existing utilities. Temporary connections shall be provided, as required, to insure there is no interruption of existing services. Any damage resulting from the Work of this Contract shall be promptly repaired by the Contractor at his own expense in a manner approved by the Engineer and to the requirements of any authority having jurisdiction. Where it is required by the authority having jurisdiction that they perform their own repairs or have them done by others, the Contractor shall be responsible for all costs thereof.

Where excavations by the Contractor require any utility lines or appurtenant structures to be temporarily supported and otherwise protected during the construction work, such support and protection shall be provided by the Contractor. All such work shall be performed in a manner satisfactory to the Engineer and the respective authority having jurisdiction over such work. In the event the Contractor fails to provide proper support or protection to any existing utility, the Engineer may, at his discretion, have the respective authority provide such support or protection as may be necessary to insure the safety of such utility, and the costs of such measures shall be paid by the Contractor.

1.18 ALTERATIONS OF EXISTING WATER MAINS AND SERVICES. The cutting, reconstructing, or relocating of any existing water mains or water service connections, necessitated to permit construction of the Work under this Contract, shall be performed by the Contractor in accordance with the authority having jurisdiction. The cost of all Work and material, including inspection, permits and penalties, shall be included in the Contract price.

The Contractor shall negotiate with the authorities having jurisdiction regarding the operating of all valves in any existing water mains.

If the Contractor finds it necessary to shut off any existing water mains in service, the Contractor shall ascertain, from the authorities having jurisdiction, the shut-off times considered appropriate for shut off, prior to shutting off the valve.

The Contractor shall receive no extra payment for the times such shutoffs and alterations have to be made or due to delays incurred in conjunction with these alterations.

1.19 EASEMENT AND/OR RIGHT-OF-WAY ACROSS PRIVATE PROPERTY. When working in easements or rights-of-way, the Contractor shall comply with the specific requirements shown on the Contract Drawings at their appropriate locations and/or as specified in these Specifications. In addition to those specific requirements, the Contractor shall comply with, but is not limited to, the following:

> The Contractor shall strip and separately stockpile (in the area where sufficient room permits) the topsoil required to be removed from each individual parcel to accommodate the Work. This topsoil shall be redistributed (or replaced) over the entire disturbed area and seeded unless otherwise directed by the Engineer. In areas where erosion may occur, sodding and pegging shall be required unless otherwise directed by the Engineer.
>
> Excess excavated material from the easement shall be placed and graded on the Owner's property to the satisfaction of the Owner and/or as directed by

the Engineer. It shall not be removed from Owner's property without permission.

If there is a surplus of, or if the Owner does not desire the excess excavated material, it shall be removed as directed by the Engineer at no cost to the Owner.

Any damage caused by the Contractor's operation to the property in/or adjacent to the easement shall be either satisfactorily restored or payment made therefore at no additional cost to Owner.

Remove only those trees necessary to facilitate construction. All others shall be protected from damage during construction. Stumps and brush from trees cut down shall be removed from the property and disposed of as direct by the Engineer.

Trees of reasonable size, removed to accommodate construction, shall be cut into fireplace lengths and stored on the property for the Owner (if requested), unless otherwise directed by the Engineer.

In addition to the specific requirements on the Contract Drawing and/or as specified in these Specifications, the Contractor, where required, shall install temporary fences and/or barricades at the work site for the protection of the public and the property Owner (and his interest, such as children, livestock, pets, and automobiles). The type and placement of fences and/or barricades shall be to the satisfaction of the Owner and/or as directed by the Engineer.

Stones or other undesirable material unearthed due to construction operations shall be removed from the property to the satisfaction of the Owner and/or as directed by the Engineer.

Existing structures or facilities such as driveways, private roads, fences, culverts, water reservoir ponds on or near the easement, underground piping, wells, field drains or tiles, and open ditches, shall be restored to a condition that existed prior to construction, and to the satisfaction of the Owner and/or as directed by the Engineer.

Ascertain the location, condition and depth and also protect any well on or near the easement, which in any way may be affected by construction operations. The Contractor shall be responsible for any and all resulting damages, claims, actions or causes of action arising therefrom. In the event a well is damaged or ceases to function because of the construction operations, a source of water sufficient for the use of the well owner shall be provided by the Contractor at no additional cost. This source of water is to be supplied until such time as the well is restored to its original condition.

Conform to all requirements stated in the Contract Documents with regard to restoration work in private easements including those requirements stated above and those shown on the Drawings at no additional cost.

Complete all restoration work as soon as possible so as to cause a minimum of interference with the normal usage of the land by the Owner and for the control of soil erosion. The restoration or reconstruction of drainage structures, water reservoirs, wells and other facilities, shall be performed as soon as is practical, and in co-operation and compliance with the Owner and/or local agency having jurisdiction over, and/or as directed by the Engineer.

1.20 CLAIMS BY ONE CONTRACTOR FROM DAMAGE BY ANOTHER CONTRACTOR. Each Contractor, in signing his Contract, agrees that if another Contractor working on this project makes a claim against the Owner for money damages due to loss of time, non-payment, or other reasons caused or occasioned by the method of operation or lack of progress of the Contractor, and the allegations are substantiated in the opinion of the Owner, the Owner may assess in turn such money damages and withhold from progress payment against the offending Contractor.

1.21 HISTORICAL SPECIMENS. Any and all specimens of historical or scientific value or interest encountered in the Work shall be preserved and delivered to the Engineer.

1.22 ABBREVIATIONS. The following listed group of letters or abbreviations, wherever they appear in the Contract, shall mean and be interpreted as indicated below ("." May or may not appear in abbreviation):

A.A.S.H.T.O	American Association of State Highway and Transportation Officials.
A.C.I.	American Concrete Institute.
A.E.I.C.	Association of Edison Illuminating Companies.
A.F.B.M.A.	Anti-Friction Bearing Manufacturer Association.
A.G.A.	American Gas Association.
A.G.M.A.	American Gear Manufacturers Association.
A.H.D.G.A.	American Hot Dip Galvanizers Association.
A.M.C.A.	Air Moving and Conditioning Association.
A.I.S.C.	American Institute of Steel Construction.

A.I.S.I.	American Iron and Steel Institute.
A.N.S.I.	American National Standards Institute.
A.P.I.	American Petroleum Institute.
A.R.E.A.	American Railway Engineering Association
A.S.C.E.	American Society of Civil Engineers.
A.S.H.R.A.E.	American Society of Heating, Refrigeration and Air Conditioning Engineers.
A.S.M.E.	American Society of Mechanical Engineers.
A.S.P.E.	American Society of Plumbing Engineers.
A.S.T.M.	American Society for Testing and Materials.
A.W.G.	American Wire Gauge.
A.W.P.A.	American Wood Preservers' Association.
A.W.S.	American Welding Society.
A.W.W.A.	American Water Works Association.
B.O.C.A.	Building Officials and Code Administrators.
C.E.M.A.	Conveyor Equipment Manufacturers Association.
C.S.	Commercial Standards.
C.R.S.I	Concrete Reinforcing Steel Institute.
D.E.Co.	Detroit Edison Company.
D.O.H.	Department of Health
D.P.W.	Department of Public Works - City of Detroit.
D.W.S.D.	Detroit Water & Sewerage Department.
E.J.C.D.C.	Engineer’s Joint Contract Documents Committee, American Consulting Engineers Council, 1050 15th

	Street, N.W. Washington, D.C. 20005.
E.P.A.	Environmental Protection Agency.
E.P.M.D.	Environmental Protection & Maintenance Department of the City of Detroit.
F.C.I.	Fluid Control Institute.
Fed. Spec.	Federal Specification, issued by the Federal Supply Service, General Services Administration, U.S. Government.
F.M.	Factory Mutual System (FM), 1151 Boston-Providence Turnpike, Norwood, MA 02062.
I.B.R.	Institute of Boiler and Radiator Manufacturers.
I.E.E.E.	Institute of Electrical and Electronics Engineers.
I.P.C.E.A.	Insulated Power Cable Engineers Association.
I.R.I.	Industrial Risk Insurers.
I.S.A.	Instrument Society of America.
I.S.O.	International Standard Organization.
J.I.C.	Joint Industry Conference Standards.
M.D.E.Q.	Michigan Department of Environmental Quality (State of Michigan).
M.D.O.H.	Michigan Department of Health.
M.D.O.T.	Michigan Department of Transportation.
M.I.O.S.H.A.	Michigan Occupational Safety and Health Act.
M.S.S.	Manufacturers Standardized Society (MSS).
N.B.F.U.	National Board of Fire Underwriters.
N.B.S.	National Bureau of Standards.
N.C.P.I.	National Clay Pipe Institute.

N.C.P.W.B.	National Certified Pipe Welding Bureau.
N.E.B.B.	National Environmental Balancing Bureau.
N.E.C.	National Electrical Code.
N.E.M.A.	National Electrical Manufacturers Association.
N.F.P.A.	National Fire Protection Association.
N.L.G.I.	National Lubrication Grease Institute.
N.P.D.E.S.	National Pollutant Discharge Elimination Systems.
N.P.T.	National Pipe Thread.
N.S.C.	National Safety Council.
N.S.F.	National Sanitation Foundation.
O.S.H.A.	Occupational Safety and Health Administration.
O.S.Y.	Outside Screw and Yoke.
P.D.I.	Plumbing and Drainage Institute.
P.S.	Pump Station.
S.D.I.	Steel Deck Institute.
S.J.I.	Steel Joist Institute.
S.M.A.C.N.A.	Sheet Metal and Air Conditioning Contractors National Association, Inc.
S.S.P.C.	Steel Structure Painting Council.
Ten State Standards	Great Lake Upper Mississippi River Board of State Public Health and Environmental Managers.
U.L.	Underwriters' Laboratories.
U.S.E.P.A.	U.S. Environmental Protection Agency.
U.S.S.G.	United States Standard Gage.

W.C.A.P.C.P.	Wayne County Air Pollution Program.
W.C.D.E.	Wayne County Department of Environment.
W.O.G.	Water, Oil, and Gas.
W.S.P.	Working Steam Pressure.
W.W.T.P.	Wastewater Treatment Plant.

1.23 REFERENCES.

1.23.01 Specifications by Reference. Where reference is made in the Specifications section to specifications or standards of any technical society, professional association, or governmental agency, it is understood and agreed that such specifications or standards are as much a part of the Specifications Section as though fully repeated therein.

1.23.02 Materials by Reference. A material included in more than one Section of the Specification will, in general, be specified in detail in only one of the Sections.

In other Sections, the material is specified by reference to the Section containing the specifications for the same material, and such Specifications shall be considered as much a part of the other Sections as if they were therein repeated in full.

1.24 VARIOUS ABBREVIATIONS.

The miscellaneous abbreviations herein, together with others in general use, are applicable to these Master Standard Specifications and to project Plans or other Contract Documents.

ABAND	Abandoned
AC	Asphalt Concrete
ACWS	Asphalt concrete wearing surface
ALT	Alternate
Amp	Ampere(s)
APA	Authorized Public Agency
Atm	Atmosphere(s)

Avg	Average
AWG	American Wire Gage (nonferrous wire)
AMER STD	American Standard
Amp	Ampere(s)
Ann	Annual
APA	Authorized Public Agency
B/B	Back to Back
B/W	Back of walk
BC	Beginning of curve
BDRY	Boundary
BF	Bottom of footing
BH	Brinell Hardness
BHP	Brake horsepower
BM	Bench mark
BOD	Biochemical oxygen demand
Btu	British thermal unit(s)
BVC	Beginning of vertical curve
C	Celsius (centigrade)
C to C	Center to Center
C&G	Curb and gutter
C/C	Center to center
CAB	Crushed aggregate base
CAL	Calorie(s)
CAP	Corrugated Aluminum pipe

CB	Catch Basin
CBOD	Carbonaceous biochemical oxygen demand
CBP	Catch Basin Connection Pipe
Cc	Cubic centimeter(s)
CCTV	Closed Circuit TV
CFD	Cubic feet per day
CFH	Cubic feet per hour
CFM	Cubic feet per minute
CFR	Code of Federal Regulations
CFS	Cubic feet per second
CFT	Cubic foot
CI	Cast Iron Pipe
CIA	Construction Influence Area
CIP	Compacted in Place
CL	Clearance, center line
CLF	Chain link fence
CM	Centimeter(s)
CML	Cement mortar-lined
CO	Cleanout (Sewer)
COD	Chemical oxygen demand
COL	Column
CONC	Concrete
CONN	Connection
CONST	Construct, Construction

COORD	Coordinate
CPM	Critical Path Method
CP	Constant pressure
CSDS	DWSD Control System Design Standards
CSP	Corrugated steel pipe
CTV	Cable TV
CU	Cubic
CU FT	Cubic foot (feet)
CU IN	Cubic inch(es)
cu yd	Cubic yard(s)
CV	Check valve
C	Coefficient, valve flow
CYD	Cubic yard
DB	Decibels
DBA	Decibels (A scale)
DBL	Double
DBT	Dry-bulb temperature
DC	Direct current
DCB	Detailed Cost Breakdown
DEG	degree(s)
DIA	Diameter
DI	Ductile iron
DL	Dead load
DO	Dissolved oxygen

DP	Pressure drop or difference
DPT	Dew point temperature
DS	Dissolved solids
DT	Drain Tile
DWG	Drawing
DWSD	Detroit Water & Sewerage Department
DWY	Driveway
DWY APPR	Driveway approach
E/P	Edge of pavement
EA	Each
Eat	Entering air temperature
EC	End of curve
EDR	Equivalent direct radiation
EF	Each face
EFF	Efficiency
EG	Edge of gutter
EGL	Energy grade line
El	Elevation
ELC	Electronic lighting conduit
ENGR	Engineer, Engineering
ESMT	Easement
ETB	Emulsion-treated base
EVC	End of vertical curve
Ewt	Entering water temperature

EX ROW	Existing Right of Way
EXC	Excavation
EXP JT	Expansion joint
EXST	Existing
F	Fahrenheit
F TO F	Face to face
F&C	Frame and cover
F&I	Furnish and install
F/C	Face of Curb
FA	Face area
FAB	Fabricate
FAS	Flashing arrow sign
FBM	Board Foot
FC	Foot-candle
FD	Floor drain
FDN	Foundation
FG	Finished grade
FH	Fire hydrant
FL	Flow line
FM	Factory Mutual System
FO	Fiber Optics Cable
FPD	Feet per day
FPH	Feet per hour
FPM	Feet per minute

FPS	Feet per second
FREQ	Frequency
FS	Federal Specification
FSS	Federal Specifications and Standards
FT	Foot (feet)
FTG	Footing
FT-LB	Food-pound
ft-lb/min	Foot-pounds per minute
FT-LB/SEC	Foot-pounds per second
FW	Face of wall
G	gram(s)
GA	Gauge
GAL	Gallons
GALV	Galvanized
GC-MS	Gas chromatography and mass spectrometry
GIP	Galvanized iron pipe
GM/CC	Grams per cubic centimeter
GPD	Gallons per day
GPD/CU FT	Gallons per day per cubic foot
GPD/SQ FT	Gallons per day per square feet
GPH	Gallons per hour
GPM	Gallons per minute
GPS	Global Positioning System
GPS	Gallons per second

GR	Grade
GR	Grain(s)
GRTG	Grating
GSP	Galvanized steel pipe
H	High or height
HGL	Hydraulic grade line
HORIZ	Horizontal
HP	Horsepower
HP-HR	Horsepower-hour
HR	Hour(s)
HYDR	Hydraulic
Hz	Hertz
ID	Inside diameter
In	Inch(es)
INCL	Including
INSP	Inspection
INV	Invert
IPS	Inches per second
JT	Joint
JTU	Jackson turbidity unit(s)
K	Kelvin
KA	Kilo - amperes
Kg	Kilogram(s)
Km	Kilometer(s)

KV	Kilovolt(s)
KVA	Kilovolt-ampere(s)
KVAR	Kilovar (kilovolt-amperes reactive)
KWH	Kilowatt-hour(s)
L	Liter(s)
LAB	Laboratory
LAT	Lateral
LB	Pound(s)
LBS/DAY	Pounds per day
LBS/DAY/CU FT	Pounds per day per cubic foot
LBS/DAY/SQ FT	Pounds per day per square foot
LFT	Linear foot
LL	Live load
LONG	Longitudinal
LP	Lamp post
LSUM	Lump sum
M	Meter(s)
Ma	Milliampere(s)
MAINT	Maintenance
MAX	Maximum
MBH	Thousand Btu per hour
MCF	Thousand cubic feet
MCL	Michigan Compiled Laws

MEAS	Measure
mg	Milligram(s)
MG	Million gallons
mg/L	Milligrams per liter
MGD	Million gallons per day
MH	Manhole, maintenance hole
MIL	Military Specification
Min	Minute(s)
MISC	Miscellaneous
ML	Milliliter(s)
MLSS	Mixed liquor suspended solids
MMUTCD	Michigan Manual of Uniform Traffic Control Devices
MM	Millimeter(s)
MOD	Modified, modify
MON	Monument
MPH	Miles per hour
MS	Millisecond(s)
MSA	Michigan Statutes Annotated (number always follows)
MTM	Michigan Test Method
MULT	Multiple
MV	Millivolt(s)
MVA	Megavolt-ampere(s)
NBS	National Bureau of Standards
NC	Noise criteria

NPSH	Net positive suction head
NRC	Noise reduction coefficient
NTU	Nephelometric turbidity unit
OA	Outside air
OBS	Obsolete
OC	On center
OD	Outside diameter
OE	Outer edge
OPP	Opposite
ORIG	Original
OZ	Ounce(s)
PB	Pull box
PC	Point of curvature
PCF	Pounds per cubic foot
PCF/HR	Pounds per cubic foot per hour
PCT	Percent
PE	Polyethylene
PF	Power factor
PH	Hydrogen ion concentration
PI	Point of intersection
PL	Property line
PPB	Parts per billion
PPM	Parts per million
PSF	Pounds per square foot

PSF/HR	Pounds per square foot per hour
PSI	Pounds per square inch
PSI	Pounds per square inch
PSIA	Pounds per square inch absolute
PSIG	Pounds per square inch gauge
PVC	Polyvinyl chloride
PVMT	Pavement
PVT R/W	Private right-of-way
Q	Rate of flow in cubic feet per second
Qt	Quart(s)
QUAD	Quadrangle, Quadrant
R	Radius
R&O	Rock and oil
RA	Recycling agent
RAC	Recycled asphalt concrete
RAP	Reclaimed asphalt pavement
RBAC	Rubberized asphalt concrete
RC	Reinforced concrete
RCP	Reinforced concrete pipe
RCV	Remote control valve
REF	Reference
REINF	Reinforced or reinforcement
RES	Reservoir
RES	Resistance

REV	Revolution(s)
RH	Relative humidity
RMS	Root mean squared
ROW	Right-of-way
RPM	Revolutions per minute
RPS	Revolutions per second
RR	Railroad
S	Slope
SA	Supply air
SC	Shading coefficient
SCCP	Steel cylinder concrete pipe
SD	Storm drain
SDI	Sludge density index
SEC	Section
SF	Safety factor
SFT	Square foot
SG	Specific gravity
SV	Specific volume
SPEC	Specifications
SQ	Square
SQ CM	Square centimeter(s)
SFT	Square foot (feet)
SQM	Square meter(s)
SYD	Square yard(s)

SS	Sanitary sewer
ST HWY	State highway
STA	Station
STD	Standard
STR	Straight
STR GR	Straight grade
STRUC	Structural/Structure
SW	Sidewalk
SWD	Sidewalk drain
SYD	Square yard
TAN	Tangent
TD	Temperature difference
TDH	Total dynamic head
TDS	Total dissolved solids
TE	Temperature entering
T	Temperature
TL	Temperature leaving
TLV	Threshold limit value
TOD	Total oxygen demand
TONS	Tons of refrigeration
TOPO	Topography
TP	Total pressure
TRANS	Transition
TRQ	Torque

TS	Traffic signal or transition structure
TS	Total solids
TSC	Traffic signal conduit
TSS	Traffic signal standard
TYP	Typical
VA	Volts-ampere(s)
VAC	Vacuum
VAR	Varies, Variable
VB	Valve block
VC	Vertical curve
VERT	Vertical
VFT	Vertical foot
VOC	Volatile organic chemical
V	Volume
VP	Pressure, dynamic (velocity)
VS	Volatile solids
VSS	Volatile suspended solids
W	Watt(s)
WATCH	Work Area Traffic Control Handbook
WB	Wet-bulb
WBT	Wet bulb temperature
WCAPCP	Wayne County Air Pollution Program
WCDE	Wayne County Department of the Environment
WHD	Watt-hour demand

WHDM	Watt-hour demand meter
WI	Wrought iron
Wk	Week(s)
WM	Water meter
WT	Weight
XCONN	Cross connection
XSEC	Cross section
Yd	Yard(s)
YR	Year(s)

1.25 UNITS OF MEASURE.

1.25.01 General. U.S. Standard Measures, also called U.S. Customary System is the principal measurement system in these specifications and shall be used for construction, unless otherwise stated in the Contract Documents.

Reference is also made to ASTM E 380 for definitions of various units of the SI system and a more extensive set of conversion factors.

1.25.02 Units of Measure and Their Abbreviations.

U.S. Customary Unit (Abbreviations)	Equal To	SI Unit (Abbreviations)
1 mil (=0.001 in)		25.4 micrometer (mm)
1 inch (in)		25.4 millimeter (mm)
1 inch (in)		2.54 centimeter (cm)
1 foot (ft)		0.3048 meter (m)
1 yard (yd)		0.9144 meter (m)
1 mile (mi)		1.6093 kilometer (km)
1 square foot (ft^2)		0.0929 square meter (m^2)
1 square yard (yd^2)		0.8361 square meter (m^2)
1 cubic foot (ft^3)		0.0283 cubic meter (m^3)
1 cubic yard (yd^3)		0.7646 cubic meter (m^3)
1 acre		0.4047 hectare (ha)
1 U.S. gallon (gal)		3.7854 Liter (L)
1 fluid ounce (fl. oz.)		29.5735 milliliter (mL)
1 pound mass (lb) (avoirdupois)		0.4536 kilogram (kg)
1 ounce mass (oz)		28.3495 kilogram (kg)
1 Ton (= 2000 lb avoirdupois)		0.9072 Tonne (= 1000 kg)

1 Poise	0.1 pascal · second (Pa · s)
1 centistoke (cs)	1 square mm per second (mm^2/s)
1 pound force (lbf)	4.4482 Newton (N)
1 pound per square inch (psi)	6.8948 Kilopascal (kPa)
1 pound force per foot (lbf/ft)	1.4594 Newton per meter (N/m)
1 foot-pound force (ft-lbf)	1.3558 Joules (J)
1 foot-pound force per second ([ft-lbf]/s)	1.3558 Watt (W)
1 part per million (ppm)	1 milligram/liter (mg/L)
1 horsepower (550 ft x 1bf/s)	745.7 Watts
1 Million Gallons per Day (MGD)	1.5472 ft^3/sec
1 MGD	0.0438 m^3/sec

1.25.03 Temperature Units and Abbreviations.

Degree Fahrenheit (°F):	Degree Celsius (°C):
°F = (1.8 x °C) + 32	°C = (°F – 32)/1.8

1.25.04 SI Units (abbreviation) Commonly Used in Both Systems.

1 Ampere (A)
1 Volt (V)
1 Candela (cd)
1 Lumen (lm)
1 second (s)

1.25.05 Common Metric Prefixes.

kilo (k)	10^3
centi (c)	10^{-2}
milli (m)	10^{-3}
micro (µ)	10^{-6}
nano (n)	10^{-9}
pico (p)	10^{-12}

1.26 DEFINITIONS.

Addendum – Written or graphic instrument issued prior to the opening of Bids which clarifies, corrects, or changes the bidding or Contract Documents. The term Addendum shall include bulletins and all other types of written notices issued to potential bidders prior to opening of Bids.

Agency – The legal entity for which the Work is being performed.

Base Course – The layer or layers of specified material of planned thickness placed on a subbase or subgrade to support a surface course.

Backfill – Material used to fill an excavation.

Backflow Preventer – Valve within piping system to keep flow moving in one direction.

Benchmark – A fixed, solid reference point with a precisely determined, published elevation.

Catch Basin – A structure designed to collect surface water and transfer it to a storm or combined sewer.

Change Order – A written order to the Contractor signed by the Agency directing an addition, deletion, or revision in the Work, or an adjustment in the Contract Price or the Contract time issued after the effective date of the Contract. A Change Order may or may not also be singed by the Contractor.

Code – The terms *Government Code, Labor Code*, etc., refer to codes of the State of Michigan.

Contract – The written agreement between the Agency and the Contractor covering the Work.

Contract Documents – Including but not limited to; Contract Addenda (which pertain to the contract documents), Notice Inviting Bids, Instructions to Bidders; Bid (including documentation accompanying Bid and any post-bid documentation submitted prior to Notice of Award) when attached as an exhibit to Contract, Bonds, general conditions, permits from other agencies, Special Provisions, Plans, Standard Plans, Details, Schedules, Master Specifications, Reference Specifications, Provisional Specifications, Supplemental Specifications and all Modifications issued after execution of Contract.

Contractor – The individual, partnership, corporation, joint venture, or other legal entity having a Contract with the Agency to perform the Work. In the case of work being done under permit issued by the Agency, the permittee shall be construed to be the Contractor. The term “prime contractor” shall mean Contractor.

Contracting Officer – The Contracting Officer shall be as defined in the Agreement, Exhibit G, Glossary

Contract Unit Price – The amount stated in the Bid for a single unit of an item of work.

Cross-Section – A profile of the ground, etc., taken at right angles to a reference line.

Crown – The uppermost point on a road, sewer, culvert or pipe cross-section.

Culvert – A structure designed to provide an opening under a road etc., usually for the transportation of water.

Cut – In construction, the excavation of material; also the measurement down from a grade mark.

Days – Days shall mean consecutive calendar’s days unless otherwise specified.

Easement – An interest or right held by one person or party in land owned by another person, whereby the first person is accorded partial use of such land for a specific purpose. An easement restricts but does not abridge the rights of the fee owner to the use and enjoyment of the easement holder’s rights.

Encroachment – Any structure illegally erected within or overhanging the R.O.W. and attached to the land i.e., a fence, building or parking lot.

Engineer – The term Engineer in the Contract Documents, Division 01 through 17, shall be synonymous with Contracting Officer as defined in the Agreement, Exhibit G, Glossary, unless stated otherwise
Engineering Survey – Preliminary and layout surveys used for construction.

Fill – Material used to raise the construction level; also, the measurement up from a grade mark.

Footing – The part of the structure which is placed in or on the ground, upon which the main structure rests.

Foundation – The portion of a structure resting upon a footing and providing support for walls and other structural components.

Geotextile – Flexible, permeable fabrics consisting of synthetic fibers or yarns oriented into a dimensionally stable network. Uses include, but are not limited to, as a blanket for filtration applications, liner, separator and for stabilization of subgrade and subbase materials.

Grading Permit – The right to enter upon a specific area of land for the purpose of grading, including the right to grade and/or alter the underlying lands, which right will expire at the completion of the construction of the described project, or upon a specified date.

House Connection Sewer – A sewer, within a public street or right-of-way, proposed to connect any parcel, lot, or part of a lot with a mainline sewer.

House Sewer – A sewer, wholly within private property, proposed to connect any building to a house connection sewer.

Invert – The lowest interior elevation of a pipe, sewer or culvert.

Luminaire – The lamp housing include the optical and socket assemblies (and ballast if so specified).

Luminaire Arm – The structural member, bracket, or mast arm, which, mounted on the standard, supports the luminaire.

Manhole – A structure which provides access to underground services such as sewer, water, phone etc.

Modification – Includes Change Orders and Supplemental Agreements. A Modification may only be issued after the effective date of the Contract.

Monument – A permanent reference point for horizontal and vertical positioning.

Person – Any individual, firm, association, partnership, corporation, trust, joint venture, or other legal entity.

Plans – The drawings, profiles, cross sections, working drawings, and supplemental drawings, or reproductions thereof, approved by the Engineer, which show the location, character, dimensions, or details of the Work.

Pre-engineering Survey – A preliminary survey which forms the basis for engineering design.

Private Contract – Work subject to Agency inspection, control, and approval, involving private funds, not administered by the Agency.

Property Survey – A survey to retrace or establish property lines or to establish the location of buildings within property limits.

Provisional Specifications – Specifications issued separate from DWSD Master Specifications that alter the Master Specifications for specific project requirements. DWSD Master Specifications are available on DWSD's official website located at http://www.dwsd.org/cust/master_spec.html

Reference Specifications and Drawings – Those bulletins, standards, rules, methods of analysis or test, codes, drawings, and specifications of other agencies, engineering societies, or industrial associations referred to in the Contract Documents. These refer to the latest edition, including amendments in effect and published at the time of advertising the project or issuing the permit, unless specifically referred to by edition, volume, or date.

Retaining Wall – A wall built to hold back an embankment.

Right of way (R.O.W.) – The entire area legally reserved for the construction, operation and maintenance of the roadway and the improvement of the roadside and/or utilities.

Roadside – That portion of the R.O.W. outside of the roadway.

Roadway – That portion of the R.O.W. reserved for vehicular use, limited by the outside edges of embankment or cut slopes and including ditches, channels and/or other structures required to facilitate drainage.

Service Connection – Service connections are all or any portion of the conduit, cable, or duct, including meter, between a utility distribution line and an individual consumer.

Setback Line – A line established by zoning ordinance, deed restriction or custom regulating the distance from the R.O.W. line of a street or highway to the point where improvements may be constructed.

Sewer – A system comprising inlets, conduits, manholes and other appurtenances to collect storm runoff from rainfall, sewage and/or fluid industrial wastes and convey these to a point of discharge.

Sidewalk – That portion of the roadway primarily constructed for pedestrian use.

Slope Stakes – Stakes placed to locate the top or bottom of a slope; also may correspond to the limits of construction when referring to roadway construction.

Special Provisions – Any provisions that supplement or modify the Standard Specifications applicable to an individual project. An Addendum is a Special Provision.

Specifications – Standard Specifications, Reference Specifications, Special Provisions, and specifications in Supplemental Agreements between the Contractor and the Board. A general term applied to all written directions, provisions and requirements concerning the performance of the work.

Standard – The shaft or pole used to support street lighting luminaire, traffic signal heads, mast arms, etc.

Standard Plans – Details of standard structures, devices, or instructions referred to on the Plans or in Specifications by title or number.

Standard Specifications – All requirements and provisions contained in this document.

State – State of Michigan.

Station – 1) A point on a baseline that is a specified distance from the point of commencement; 2) A DWSD pumping station.

Street – Any road, highway, parkway, freeway, alley, walk, or access.

Subbase – A free draining granular material, placed on the subgrade and on which the base and surfacing materials are placed.

Subgrade – That part of the finished surface of the graded earth on which the subbase, road surface and shoulders are placed.

Supervision – Supervision, where used to indicate supervision by the Engineer, shall mean the performance of obligations, and the exercise of rights, specifically imposed upon and granted to the Agency in becoming a party to the Contract. Except as specifically stated herein, supervision by the Agency shall not mean active and direct superintendence of details of the Work.

Supplemental Specifications – Specifications issued separate from DWSD Master Specifications for specific project requirements that include information not included in DWSD Master Specifications.

Title – The evidence of a person’s right to the property or the right itself.

Traffic Control Devices – Signs, signals, lighting devices, barricades, delineators, pavement markings, traffic regulators and all other equipment for protecting and regulating traffic in accordance with the MMUTCD.

Tonne – Also referred to as “metric ton”. Represents a unit of measure in the International System of Units equal to 1,000 kilograms.

Utility – Tracks, overhead or underground wires, pipeline, conduits, ducts, or structures, sewers, or storm drains owned, operated, or maintained in or across a public right of way or private easement.

Work – That which is proposed as defined by the Contract Documents to be constructed or done under the Contract or permit, including the furnishing of all labor, materials, equipment, and services.

Work Order – A written order by the Engineer or Agency requiring performance by the Contractor.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

End of Section

SECTION 01020

DOCUMENTATION STANDARDS

PART 1 - GENERAL

1.1 SCOPE. This section defines the content and format for the project documentation. It also includes reference governing standards for the documentation and for performance of the Work. The project documentation will be for DWSD's internal use for operation, facility activation, installation and testing, personnel training and verification of Contractor's performance and compliance with the Contractual requirements.

1.2 GENERAL.

1.2.01 Governing Standards. The following references are provided for use by the Contractor and all subcontractors. It is not all inclusive.

American Concrete Institute (ACI)

Association of Edison Illuminating Companies (AEIC)

American Institute of Steel Construction (AISC)

American Iron and Steel Institute (AISI)

American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018

American Petroleum Institute (API), Publications and Distribution Section, 1220 L. Street Northwest, Washington, D.C. 20005

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), 1791 Tullie Circle, N.E., Atlanta, GA 30329

American Society of Mechanical Engineers (ASME), 345 East 47th Street, New York, NY 10017

American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103

American Welding Society (AWS)

American Water Works Association (AWWA), 666 West Quincy Avenue, Denver, CO 80235

Anti-Friction Bearing Manufacturers Association (AFBMA)

Building Officials and Code Administration (BOCA)

City of Detroit Building Code

City of Detroit Ordinances and Executive Orders

Conveyor Equipment Manufacturers Association (CEMA)

DWSD Control System Design Standards (CSDS)

Detroit Edison Company (DECO)

Engineer's Joint Contract Documents Committee (EJCDC), American Consulting Engineers Council, 1050 15th Street, NW, Washington, D.C. 20005

Factory Mutual System (FM), 1151 Boston-Providence Turnpike, Norwood, MA 02062

Federal Specification (FS), General Services Administration, Specification and Consumer Information Distribution Section, (WFSIS), Washington Navy Yard, Building 197, Washington, D.C. 20407

Great Lakes Upper Mississippi River Board of State Public Health and Environmental Managers, 1997 (Ten State Standards)

Institute of Electrical and Electronics Engineers (IEEE), 345 East 47th Street, New York, NY 10017

Instrument Society of America (ISA), 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709

Insulated Power Cable Engineers Association (IPCEA)

International Standard Organization (ISO)

Michigan Department of the Environment (MDEQ)

Michigan Department of Health (MDOH)

Manufacturers Standardization Society (MSS)

Michigan Occupational Safety and Health Act (MIOSHA)

Military Specification (MIL), Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120

National Bureau of Standards (NBS)

National Electrical Code (NEC)

National Electrical Manufacturers' Association (NEMA), 2101 L Street, NW, Washington, D.C. 20037

National Fire Protection Association (NFPA), Battery March Park, Quincy, MA 02269

National Pollutant Discharge Elimination Systems (NPDES)

Occupational Safety and Health Act (OSHA)

Steel Deck Institute (SDI)

Steel Structures Painting Council (SSPC)

Technical Aid Series (TAS), Construction Specifications Institute, 601 North Madison Street, Alexandria, VA 22314

Underwriters' Laboratories, Inc. (UL), 333 Pfingston Road, Northbrook, IL 60062

The U.S. Environmental Protection Agency (USEPA)

Wayne County Air Pollution Program (WCAPCP)

Wayne County Department of Environment (WCDE)

1.3 QUALITY ASSURANCE. For products or workmanship specified by association, trade, or Federal Standards, comply with the requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

When required by an individual Specification section, obtain copies of standards, provide a copy to the Engineer, and maintain a copy at the job site throughout the submittals, planning, and execution phases of the specific Work, until Substantial Completion.

When required to verify material and equipment, the Contractor must submit copies of all standards to the Engineer. DWSD Engineering maintains full sets of current ASTM, AWWA, and NFPA standards.

1.4 DOCUMENTATION PREPARATION.

1.4.01 New Drawings. For all new drawings, the Contractor shall utilize the latest. Version of AutoCAD.
1.4.02 Drawing Categories. During the period of Contract performance, the Contractor shall prepare and submit to DWSD for review and acceptance, drawing categories as follows:

General

Architectural

Structural

Mechanical

Electrical

Instrumentation

1.4.03 Revisions. Prior to issue of the final drawings, letters or numbers (e.g., Revision A, Revision B) shall identify revisions. Revisions of drawings shall be indicated by changing revision letters in the title block, entering new revision letters, and specifying revisions in the revision column.

1.4.04 Symbols. Symbols used in documents and drawings shall conform to DWSD's standards or be extracted from a standard reference source accepted in writing by the Engineer such as the list specified below:

Institute of Electrical and Electronics Engineers

National Electrical Manufacturers Association

ISA-S5.1 - Instrumentation Symbols and Identifications

ISA-S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems

ISA-S5.5 - Graphic Symbols for Process Displays

ISA-S5.4 - Instrument Loop Diagrams

Each drawing shall use symbols from only one standard reference source. The Contractor shall furnish a symbol list with explanations that includes all nonstandard symbols used on the drawings.

1.4.05 Drafting Media. Drafting media for the final drawings shall be both magnetic media and 4 Mil (0.00762. cm) thickness mylar, double matte, drafting film. Drawings shall be drawn with undiluted permanent drafting ink.

1.4.06 Lettering Standards. Lettering shall be minimum 0.125 inch (0.3175 cm) height. All lettering shall be Simplex Regular 12 Point for general notes and dimensions, Simplex Regular 18 Points for Subtitles, Simplex Regular 24 Point for General Titles, and Simplex Slant 12 Point for all general revisions and as-builts.

1.4.07 Drawing Size. Unless otherwise agreed by DWSD, drawings shall be D-size (24 x 36 inches) (60.96 x 91.44 cm).

1.4.08 Format. Each drawing prepared by the Contractor and submitted for review shall have the following format:

Large Drawings 24 x 36 inches (60.96 cm x 91.44 cm) shall have on the bottom 2 inches (5.08 cm) on the 36 inch (91.44 cm) side the following information:

1st Box	Revision/ Check	A chart to track names and dates of revisions and checks by individuals. Identify "DESCRIPTION", "CHK'D" and "APRVD. DATE".
2nd Box	Author Identification	5 rows with "DESIGNED BY:", "DRAWN BY:", "CHECKED BY:", "PROJ. MGR:" with CAD DISK file information placed at bottom of box.
3rd Box	Seal	Location for professional seal.
4th Box	Project Title	Title of Project with scale and date placed at bottom of box.
5th Box	DWSD & Consultant	List "CITY OF DETROIT" "WATER AND SEWERAGE DEPARTMENT" and "PLAN PREPARED BY" (Consultant name and address). Also include any site positioning information below this box.
6th Box	Project Identification	List Permit Numbers, Contract Numbers, File Numbers and/or Drawing Numbers (Shop drawing or other).

Small Drawings 8.5 x 11 inches (21.59 cm x 27.94 cm) shall have on the bottom 1.5 inches (3.81 cm) on the 8.5 inch (21.59 cm) side the following information:

1st Box	Revision/ Check	A chart to track names and dates of revisions and checks by individuals. Identify "DESCRIPTION", "CHK'D" and "APRVD. DATE".
2nd Box	Author Identification	Place this box below the 1st box and provide "DRAWN BY:", "CHECKED BY:" and "APPROVED:" Also place "PLAN PREPARED BY"

		(Consultant name and address) at bottom of this box.
3rd Box	Project Title	Place at bottom middle of page the Title of Project with scale and date placed at bottom of box.
4th Box	DWSD	Place box on far right of page and include "CITY OF DETROIT" "WATER AND SEWERAGE DEPARTMENT" Provide the "Sheet" Number for individual detail and the "DWG No." to equal the drawing number of the total project drawings.

1.4.09 Layout. Drawings shall be arranged to be easily readable. Drawings shall not be crowded or cluttered. Notes shall be located as far toward the right-hand border of the drawing as possible. Circuitry shall be presented on the drawing with a minimum of crossed or offset lines. Electrical connection drawings for panels shall be drawn to reflect the actual physical wiring of the panels.

1.4.10 Line Work. The Contractor shall use DWSD's drafting standards for preparing drawings for this contract. Use the following line work when drafting drawings:

Minimum 0.01 inch (0.25 mm) for the use of Dimension Lines, Leader Lines, and background

Minimum 0.03 inch (0.76 mm) for the use in the primary object of the drawing

Maximum 0.07 inch (1.78 mm) for the use of diagrammatic drafting.

1.4.11 Existing Drawings. The Contractor may provide copies of existing drawings to any of the Contractor's designers, subconsultants, sub-contractors, or vendors. However, copies of existing drawings shall comply with standards for new drawings as defined above.

PART 2 - PRODUCTS

2.1 STANDARD SYMBOL MANUAL. The Contractor shall submit to the Engineer, five original copies of the Standard Symbol manual to be used on the Drawings.

PART 3 - EXECUTION

3.1 DRAWING GENERATION. All drawings shall be generated using a personal computer and plotter as defined in Part 1 above.

3.2 REVIEW AND ACCEPTANCE OF DOCUMENTATION.

3.2.01 Responsibilities. Acceptance of the Contractor's documentation by DWSD shall not relieve the Contractor of the responsibility to meet all of the requirements of the Contract or of the responsibilities for correction of the documents furnished by the Contractor.

End of Section

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.1 SCOPE. The items listed below beginning with Article 1.3 refer to and are the same pay items listed in the Bid Form. They constitute all of the pay items for the completion of the Work.

Where the price for an Item is stipulated in the BID FORM, Bidders shall use that price in computing the Total Bid Price.

1.2 RELATED PROVISIONS.

1.2.01 Payments and Completion; Article 9 of General Conditions (Exhibit C) of the Agreement

1.2.02 Changes in the Work. Article 12 of General Conditions (Exhibit C) of the Agreement.

1.3 LUMP SUM BID ITEMS.

1.3.01 Bid Item 6.1.1. The lump sum price for Bid Item 6.1.1 shall constitute full compensation for all the work as specified and shown in the Bidding Documents, except that work included for payment under Item Nos. 6.1.2 and other items listed under 1.4 UNIT PRICE AND ALLOWANCE ITEMS Below.

1.3.02 Bid Item 6.1.2. The lump sum price for Bid Item 6.1.2 shall constitute full compensation for Contractor's mobilization onto and demobilization off the project site for the construction of all Work elements of the project.

1.4 UNIT PRICE AND ALLOWANCE ITEMS.

1.4.01 Cash Allowance: Cash Allowance as shown in the Bid Form, if any, for specific items of work will be paid for the actual invoiced amount and shall not include any cost for Contractor support, coordination, preparation of submittals or contractor's overhead and profit.

No portion of the allowance will be used to correct Contractor's errors or omissions. At the end of the Contract, all remaining monies on the allowance shall be deducted from the Contract via a change order.

1.4.02 Provisionary Allowance: The provisionary allowance as shown in the Bid Form, if any, for unforeseen conditions or for any specific items shall be reserved for such use by the Owner to cover unanticipated costs or for other specific items. Provisionary allowance items are for the sole use of the OWNER. Work under the Provisionary Allowance Items will be done via Construction Change Directive issued by the Contracting Officer.

Payment for Work authorized under Provisionary Allowance will be full compensation for providing all Work authorized by the Owner, complete as specified or directed by the Engineer/Contracting Officer. Work authorized under the provisionary allowance may be included in subsequent Application(s) for Payment, as applicable, following authorization and performance of the Work.

At the end of the Contract, all remaining unused monies from the provisionary allowance shall be deducted from the Contract via a change order.

1.4.03 Unit Price Items: Bidders are required to develop the costs for various types of unit price items listed in the Bid Form and must agree to the use of this price in determining the final cost for this work based on the actual quantities.

The quantities to be paid for under unit price items shall be the actual quantities furnished and installed as specified and shown. The unit price for the specific item shall constitute full compensation for furnishing all labor, tools, materials and equipment, and installing the item complete, including cleaning as applicable, removal and disposal of unsound and deteriorated materials, surface preparation, repair and finishes, and clean-up, complete, as indicated and as specified.

All unused unit price items shall be deleted and the full amount shall be credited back to DWSD via Change Order.

PART 2 – PRODUCTS

Not used

PART 3 – EXECUTION

Not used

End of Section

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SECTION 01030

SUMMARY OF WORK

PART 1 - GENERAL

1.1 SCOPE. The contract documents include the following:

Contract
FORMSPEC
Master Specifications
Provision Specifications (Issued as separate document)
Supplemental Specifications
Design Drawings

It is the intent of the Contract Documents to provide the Owner with complete operable systems, sub-systems, and other items of Work.

The Contractor shall furnish all labor, superintendents, materials, equipment, tools, services, and incidentals to complete the Work required by these Specifications and as shown on the Drawings.

The Contractor shall perform the Work complete, in place and ready for continuous service, and shall include repairs, testing, training, permits, cleanup, and replacement or restoration required as a result of damages caused during this construction.

Any part of any item of the Work that is reasonably implied, or normally required to place each piece of the Work in satisfactory operating condition, shall be performed by the Contractor and the expense thereof shall be included in the total contract price bid for the Work. All miscellaneous appurtenances and other items of work that are incidental to meeting the intent of these Specifications shall be considered as having been included in the applicable lump sum or unit price bid for the Work even though these appurtenances and items may not specifically called for in the specifications.

1.2 WORK BY OWNER. Work to be performed by the Owner has been indicated on the documents. The Contractor shall coordinate operations with the Owner’s Contact personnel and other contractors, at no additional cost to the Owner.

1.3 DESIGN ENGINEER. The Design Engineer has developed FORMSPEC Section 00300, Bid Form, Article 6, “Bid Schedule” and a Provisional Specification supplementing Master Specification Section 01030 - Summary of Work to clearly define scope of work for each bid item and identify what is included and excluded.

1.4 OWNER SUPPLIED PRODUCTS. Certain items, as indicated on the Contract Documents, shall be provided by the Owner.

1.4.01 Owner Responsibilities. Provide Shop Drawings, Product Data, and Samples to Contractor to support construction and installation of Owner-supplied products.

The Contract Documents identify if Owner or Contractor will arrange and pay for delivery of materials to site. On delivery, Owner shall be given opportunity by Contractor to inspect products jointly with Contractor. Claims may be charged to the Contractor responsible or other transporter for the damage. Damaged, defective, or deficient items shall be replaced by Contractor or other responsible party as promptly as possible which shall be determined by Engineer.

1.4.02 Contractor's Responsibilities. Review Shop Drawings, Product Data, and Samples to include returned information with comments.

Receive and unload Owner or Contractor supplied products at site, and inspect for completeness or damage jointly with Engineer.

Handle, store, install and finish products.

Repair or replace items damaged after receipt.

1.5 CONTRACTOR'S USE OF SITE AND PREMISES. Refer to Article 4 of the General Conditions (Exhibit C) of Agreement and Master Specification Section 01110, Construction Facilities and Identification for general requirements regarding Contractor's use of site and premises.

The Contractor shall provide a completely equipped first aid kit at the site of each location where the Work is progressing. The Contractor shall designate a responsible member of the organization for administering first aid at all times while the Work is in progress.

Contractor shall maintain the flow in all existing sanitary and storm sewers during construction. Sewer systems experience surcharge conditions during wet weather events. No additional compensation will be considered by Owner for bypass pumping. Payment for said costs is to be included in the unit price for the Work required.

1.6 WORK SEQUENCE. Work shall be performed in accordance with project specification approved by Owner.

1.7 WORK TO CONFORM. During its progress and on its completion, the Work shall conform truly to the lines, levels, and grades indicated on the Drawings or given by the

Engineer, and shall be built in a thoroughly substantial and workmanlike manner, in strict accordance with the Drawings, Specifications, and other Contract Documents. Written directions will be provided on a basis to be determined, by the Engineer.

1.8 OWNER OCCUPANCY. Cooperation with the Owner is mandatory to minimize a conflict. Facilitate Owner's operations during transition to Owner occupancy.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

End of Section

SECTION 01040

CONTROL OF WORK

PART 1 - GENERAL

1.1 SCOPE. This section describes the requirements for Control of Work in addition to the requirements for Control of Work described in the General Conditions (Exhibit C) of the Agreement..

1.2 GENERAL.

1.2.01 Coordination. The Contractor shall furnish personnel, equipment and construction aids that will be efficient, appropriate, and sufficient to secure a satisfactory quality of work and a rate of progress that will ensure the completion of the Work within the time stipulated in the Contract Documents. Contractor shall coordinate with 'Miss Dig' and other Agencies having jurisdiction over property or structures in and around the construction area.

If at any time, Contractor's resources appear to the Engineer to be inefficient, inappropriate, or insufficient to achieve the required quality or rate of progress of the Work, the Engineer may direct the Contractor to increase the efficiency, change the character, or increase the number of personnel and equipment, and the Contractor shall comply. Failure of the Engineer to give such a direction shall in no way relieve the Contractor of its obligations to secure the required quality or rate of progress of Work.

1.2.02 Hours of Work. The Contractor may normally prosecute the Work during the daylight hours of any weekday, providing that the operations are conducted as to not create a public nuisance or disturb the peace. However, should the Contractor be stopped, by order of a public authority, from working at times that are contrary to or in violation of any law, ordinance, permit, or license, the Contractor shall not be entitled to an extension of time due to such stoppages.

At the beginning of Work on this Contract, the Contractor shall notify the Engineer in writing, of the days and hours that will constitute a normal workweek. Whenever the Contractor intends to depart from the specified workweek, the Contractor shall notify the Engineer at least 24 hours in advance in writing of the change so that the Engineer may make the necessary arrangements to have required inspectors assigned to the Work. Failure of the Contractor to give such advance notice may cause the Engineer to require removal or uncovering of the work performed during such time without the Engineer's knowledge.
If an emergency arises that would require work to be performed outside of the normal working hours of the specified workweek to save or protect life or property, the requirements of the 24-hour notification would be waived. The Contractor shall notify

the Engineer as soon as the Contractor determines that an emergency exists that necessitates a change in or extension of the normal hours of work. However, the Contractor's determination of the existence of an emergency is subject to review and revision by the Engineer.

The normal workweek schedule and/or daily hours of work shall be altered at the Engineer's direction, when, in his judgment, such alteration is necessary to maintain the required progress of the Work.

1.2.03 Shutdowns

A shutdown shall be defined as a portion of the normal operation of a unit or conduit that has to be suspended or taken out of service in order to perform the specified Work. For each shutdown, Contractor shall compile an inventory of labor and materials required to perform tasks, an estimate of the time required, including time for the Owner to take down and start up the unit or conduit, and a written description of steps required to complete all tasks. The inventory, the estimate, and written procedures shall be submitted to the Engineer for review 30 calendar days prior to the proposed start date of the shutdown. Contractor shall also request, in writing from the Engineer, approval for each shutdown a minimum of 14 calendar days prior to the proposed shutdown date. No shutdown shall be initiated until the inventory of materials and labor is verified by the Engineer on site prior to the proposed start date.

The Work required herein and any other Work required by the Engineer which may interrupt the normal operations shall be accomplished at such times that will be convenient to the Owner. The Contractor shall note that shutdowns may be during the nighttime hours or during weekend hours. The Contractor shall include in its bid price all overtime and/or premium time required for performing any work associated with these shutdowns.

Contractor shall also have on hand and located in close proximity to the Work area, all tools, equipment, spare parts and materials, both temporary and permanent, necessary to complete each Work category without interruptions. Adequate numbers of personnel shall be scheduled for each shutdown, so that the Work shall be accomplished within the specified time frame. The Engineer shall be satisfied that Contractor has complied with these requirements, to the fullest extent possible, before shutdowns will be authorized.

If Contractor's procedures cause an unscheduled shutdown of the facilities, Contractor shall perform the Work as necessary to immediately re-establish satisfactory operation. Contractor shall notify the Engineer, in writing, immediately of any unscheduled shutdown. Contractor shall permit Owner's personnel to work with Contractor's personnel, as required, to maintain the facilities in continuous satisfactory operation. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of the facilities that result in fines levied by regulatory agencies shall be the responsibility of Contractor if it is demonstrated that Contractor was negligent in the Work or did not exercise proper precautions in the conduct of the Work.

Shutdowns of Electrical and Control Systems: Contractor and the Owner shall each lock out and tag circuit breakers and switches operated by the Owner and shall check cables and wires to be sure that they are de-energized to ground potential before Work begins. Upon completion of the Work, Contractor shall remove the locks and tags and notify the Engineer that the facilities are available for use. The Owner will then remove its locks and place facilities back into use. The Contractor shall supply its own locks. Locks shall be checked at the beginning of each shift. Contractor shall comply with the Owner's Lockout/Tagout procedure. Shutdowns for any electrical wiring or I&C cables shall be coordinated with the Owner.

1.2.04 <u>General Requirements</u>

The Contractor shall:

Develop a program, in cooperation with the Engineer to provide for the construction and putting into service the new work in the most orderly manner possible and in coordination with continued operations of the facilities and all ongoing construction projects at the time of construction of this project;

Adhere to such program except as deviations therefrom are expressly permitted by the Engineer;

Plan all work of connecting with, cutting into, and reconstructing existing pipes or structures so as not to interfere with the operation and maintenance of the existing facilities. Schedule work that will impact operation of existing facilities for the shortest possible time and when the demands on the facilities best permit such interference, even though it may be necessary to work outside of normal working hours to meet these requirements;

Dewater process and utility pipelines back to nearest closed valve at the beginning of each piping shutdown.

Provide all appropriate means and methods to ensure that water services in the areas/facilities associated with this project are maintained uninterrupted during construction;

Make minor modifications in such work relating to existing structures as may be necessary, without additional compensation;

Before starting any work which will interfere with the operation of the existing facilities, do all possible preparatory work and shall see that all tools, materials, and equipment to be installed are made ready and at hand;

Conduct construction operations in most orderly manners such that these operations (a) interfere as little as possible with the operations of the existing facilities and other ongoing construction contracts, and (b) does not damage existing equipment, structures, etc. or cause disruption to the operations of the existing facilities;

Make no claim for additional compensation by reason of delay or inconvenience in adapting his operations to the need for continuous operations of the existing facilities; and

Do not begin any portion of Work that will interference with continued operations of the facilities until such schedule is accepted and approved by the Engineer.

1.3 PRIVATE LAND. The Contractor shall not enter or occupy private land outside of the designated construction area or property limits, except as specified in the Contract Documents.

1.4 PLANNED CONSTRUCTION LOCATIONS. The work shall be installed substantially as indicated on the Drawings, but the Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with planned or existing structures or for other reasons.

Where pipe fittings or other items are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from installing different or additional items where required.

1.5 OPEN EXCAVATIONS. Contractor shall adequately safeguard all open excavations by providing temporary barricades, caution signs, lights, and other means to prevent accidents to persons or damage to property. The Contractor shall, at its own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Bridges provided for access during construction shall be removed when no longer required. The length of an open trench will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street, and requiring that the trench not remain open overnight.

The Contractor shall take precautions to prevent injury to personnel due to open trenches. All trenches, excavated materials, equipment, or other obstacles that could be dangerous to the public, shall be well lit at night.

1.6 TEST PITS. Test pits for the purpose of locating underground pipelines or structures in advance of the construction shall be excavated and backfilled in accordance with specifications and drawings by the Contractor at the direction of the Engineer. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface shall be restored and maintained in a manner satisfactory to the Engineer.

1.7 COOPERATION WITHIN THIS CONTRACT. All firms or persons authorized to perform any Work under this Contract shall cooperate with the Contractor and its subcontractors or trades, and shall assist in incorporating the work of other trades where necessary or required.

Cutting, patching, drilling, and fitting shall be carried out where required by the trade or subcontractors having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

The Contractor shall phase the Work so that all chases or openings for the installation of its own or any other Contractor's or subcontractor’s work are available to prevent delays. The Contractor shall see that all sleeves or forms are delivered to the work area and properly set in ample time to prevent delays. The Contractor shall see that all such chases, openings, and sleeves are located accurately and are of proper size and shape. The Contractor shall consult with the Engineer and any Contractors and subcontractors related to this Work.

In case of failure to leave or cut all such openings or have all such sleeves provided and set in the proper time, the Contractor shall cut them or set them afterwards at the Contractor’s expense. In so doing, the Contractor shall confine the cutting to the smallest extent possible consistent with the Work to be done. In no case shall piers or structural members be cut without the written consent of the Engineer.

The Contractor shall carefully fit around, close up, repair, patch, and point around the Work specified herein to the satisfaction of the Engineer.

All of the Work shall be done by careful workers competent to do such work and with the proper small hand tools. Power tools shall not be used except where, in the opinion of the Engineer, the type of tool proposed can be used without damage to any Work or structures and without inconvenience or interference to the operation of any facilities. The Engineer's concurrence with the type of tools shall not in any way relieve or diminish the responsibility of the Contractor for such damage, inconvenience, or interference resulting from the use of such tools.

The Contractor shall not alter or permit any of its subcontractors to alter the Work of any other Contractor or subcontractors working on said job, except with written consent of the Contractor or subcontractors whose Work is to be altered or with the written consent of the Engineer. All cutting, patching, or repairing made necessary by the negligence, carelessness, or incompetence of the Contractor or any of its subcontractors, shall be the responsibility of the Contractor and shall be done by or at the expense of the Contractor.

1.8 OPENINGS, CHASES, SLEEVES AND INSERTS. Where pipes or conduits are to pass through slabs or walls, or where equipment frames or supports are to be installed as an integral part of an opening, the sleeves, opening forms or frames shall be furnished by the installer of the pipes, conduits, or equipment, and shall be placed by the Concrete Contractor. Where hanger inserts and similar items are to be installed as an integral part of a slab or wall, they shall be furnished by the installer of the pipe or other equipment requiring the hanger, and shall be placed by the Concrete Contractor.

When requested by the Concrete Contractor, Contractors installing pipes, conduits, ducts, or equipment in openings or chases in slabs and walls, shall furnish all necessary information, instructions, and materials for accurate installation of the required openings, chases, sleeves, frames, and inserts in concrete. When the required openings, chases, sleeves, frames, and inserts are secured in position, just prior to construction of the surrounding slab or wall, the Contractor for whom the items are installed shall field verify that the numbers, locations, and settings are correct. The Concrete Contractor shall schedule the operations to provide a reasonable opportunity and time interval for such inspection.

Any cost resulting from the correction of defective, ill-timed, or incorrectly located Work, or for subsequent Work which becomes necessary because of omitted openings, chases, sleeves, frames, and inserts, shall be borne by the responsible Contractor. To this end, no Contractor shall arbitrarily cut, drill, alter, damage, or otherwise endanger the work or another Contractor. The nature and extent of any corrective or additional Work shall be subject to the approval of the Engineer following consultation with the Contractors involved.

1.9 PROTECTION OF CONSTRUCTION AND EQUIPMENT. All newly constructed Work shall be carefully protected from damage in accordance with Contract Documents. No wheeling or walking or placing of heavy loads is allowed and the Contractor, at its own expense, shall reconstruct any portions damaged.

All structures shall be protected in a manner approved by the Engineer. If, in the final inspection of the Work, any defects, faults, or omissions are found, the Contractor shall cause the same to be repaired or removed and replaced by proper materials and workmanship without extra compensation for the materials and labor required. The Contractor shall be fully responsible for the satisfactory maintenance and repair of the construction and other Work undertaken herein, for the warranty period described in the Contract Document, or until the end of the maintenance period, whichever is longer.

The Contractor shall take all necessary precautions to prevent damage to any part of the Work due to water pressure during and after construction until such Work is accepted by the Engineer.

1.10 PRECAUTIONS DURING ADVERSE WEATHER. The Contractor shall take all necessary precautions during and against the possibility of adverse weather, so that the Work may be done properly and satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood and building-paper shelters, or other suitable means.

During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently warm so that a proper bond will occur, and proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means resulting in a moist or a dry atmosphere according to the particular requirements of the Work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used. The Contractor shall provide suitable means of protection to prevent freezing below slabs and any other Concrete Work to frost heave. This shall include all existing and new facilities.

1.11 CONFINED SPACE ENTRY. Applicable confined space entry procedures shall be followed.

At the preconstruction meeting, the Contractor shall submit to the Engineer a copy of their safety program for confined space entry in accordance with current OSHA and MIOSHA requirements. Prior to entry into any confined space, the Contractor shall submit to the Engineer a copy of their “daily” entry permit in accordance with current OSHA and MIOSHA requirements.

Contractor shall perform all work in accordance with the latest edition of Construction Safety Standards as adopted by the Michigan Department of Labor Construction Safety Standards for Occupational Health.

Contractor shall perform all work in accordance with the latest edition of Michigan Department of Environmental Quality, Occupational Health Standard for Construction.

Contractor shall comply with the latest edition of the requirements, specifications and standards as provided for under the Michigan Occupational Safety and Health Act., as amended, and in force at the date thereof and all other applicable Owner, Federal, State and Local requirements, ordinances, statutes and laws.

PART 2 – PRODUCTS

2.1 MATERIALS. Contractor shall provide materials for construction aids. They may be new or used, provided that they are suitable for the intended purpose and do not violate requirements of applicable codes and standards. Maintain facilities and equipment in first-class condition.

2.2 CONSTRUCTION AIDS. Contractor shall provide construction aids and equipment necessary to facilitate the execution of the Work, such as scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes, and other such facilities and equipment. Refer to respective sections for particular requirements for each trade.

When permanent stair framing is in place, provide temporary treads, platforms, and railings for use by construction personnel.

PART 3 - EXECUTION

3.1 PREPARATION. Contractor shall consult with the Engineer, review site conditions and factors that will affect construction procedures, and identify necessary construction aids. Determine if adjacent properties and public facilities will be affected by execution of the Work and develop strategies to address impacts.

3.2 INSTALLATION. Contractor shall install construction aids, where required, and use in accordance with OSHA/MIOSHA requirements and regulations. Relocate construction aids, as construction progresses, if storage or Work requirements change, or to accommodate legitimate requirements of the Engineer, Owner, or other Contractors employed at the site.

3.3 REMOVAL. Completely remove temporary materials, equipment, and services when construction needs can be met by the use of permanent construction and at the completion of the Work. Remove foundations and underground construction aids. Grade areas of the site affected by temporary installations to required elevations and slopes, and clear fire area.

Clean and repair any damage caused by installation or use of temporary facilities. Restore permanent facilities used for temporary purposes to original condition unless otherwise specified.

End of Section

SECTION 01050

PROGRESS SCHEDULES AND PAYMENT SUBMITTALS

PART 1 - GENERAL

1.1 SCOPE. This section adds to and builds upon Article 9: PAYMENTS AND COMPLETION of General Conditions (Exhibit C) of the Agreement. This section also builds upon FORMSPEC 01310, "Progress Schedule (CPM Standard Form)".

1.2 GENERAL.

1.2.01 Progress Schedules. Every 30 days, the contractor shall prepare a package of documents known as the Progress Schedule Submittal. The Progress Schedule package includes three main components, namely Revision, Payment, and Proposal Submittals that are comprised of additional sub-components as listed below.

In many cases, the products in the different submittals duplicate each other. This allows each submittal to be coordinated and evaluated independently of the others. Also, please note that not all submittals are submitted each month.

Revision Submittals – May revise the Record Schedule (Submit every three Months)

Detailed Cost Breakdown

Activity Reports

Schedule of Values

Logic Diagrams

Short Term Schedule

Payment Submittals – Initiates payment to Contractor (Submit Monthly)

Pay Application

Detailed Cost Breakdown

Activity Reports

Schedule of Values

Short Term Schedule

Proposal Submittal – Supports Proposals or Claims for Changes in Contract (Submit one month before Revision Proposal is due or more often as needed)

Detailed Cost Breakdown

Activity Reports

Schedule of Values

Logic Diagram Plots

The activity reports are based on the CPM Progress Schedule and discuss progress by CPM Activity. CPM Schedule requirements are detailed in FORMSPEC Section 01310, "Progress Schedule (CPM Standard Form)."

1.2.02 Initial Progress Schedule (Rev 0). The initial Progress Schedule is known as Rev 0 and, once the documents are reviewed and accepted by the Engineer, becomes the Record Schedule. Any additional modifications to the contract dates, scope, or costs are managed through approval of subsequent Progress Schedule submittals by the Owner.

The Detailed Cost Breakdown is managed initially as a separate submittal from the Rev 0 Submittal and is due 10 days after the Notice to Proceed is issued. However, it becomes part of the Progress Schedule and should be resubmitted with the Rev 0 Submittal which is due five days after the second Progress Payment period closes. The Rev 0 Submittal shall include:

Narrative detailing Contractor's Site Management Plan, Construction Equipment Usage, and Labor Buildup over first three months

Critical Path Method (CPM) Progress Schedule

Detailed Cost Breakout

Schedule of Values

Short-Term Schedules

Logic Diagrams

Resource Plots

1.2.03 Initial Interim Progress Schedule (Interim Rev 0). As an option, if the complete Rev 0 can not be prepared, the Engineer can authorize the submittal of an Interim Rev 0 that includes a Progress Schedule Submittal covering just the first 3 months of the project. If this approach is used, the Interim Rev 0 is due 10 days after the Notice to Proceed is issued.

1.2.04 Payment Submittals. The Contractor shall submit Payment Submittals monthly to the Engineer in accordance with the Agreement Between Owner and Contractor. The Engineer shall establish schedule and cutoff dates for Progress Payment periods.

Payment Submittals shall be typed on Application for Payment forms provided by the Owner, with itemized data typed on 8 1/2-inch x 11-inch (216mm x 279mm), or 8 1/2-inch x 14-inch (216mm x 356mm) white paper sheets.

Provide format, schedules, line items and values as accepted by the Engineer in the Schedule of Valves. Fill in the required information, including that for Change Orders executed prior to date of submittal of application. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets. Execute certification with signature of a responsible officer of Contract firm.

On continuation sheets, fill in total list of all scheduled component items of work, with item number and scheduled dollar value for each item. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored. Round off values to nearest dollar, or as specified for Schedule of Values. List each Change Order executed prior to date of submission at the end of the continuation sheets. List Change Order by number and description as for an original component item of work.

To receive approval for payment on component material stored on site, submit copies of the original paid invoices with the application for payment.

Contractor is to submit a Surety Acknowledgement of Payment Requests letter showing amount of progress payment which the Contractor is requesting and unconditional partial waiver of liens from major subcontractors and vendors through last Progress Payment issued to Contractor.

The first three Payments Submittals shall be based on the DCB and Rev 0 Submittal or Interim Rev 0 Submittal.

1.2.05 Progress Payments. Payment Submittals shall be submitted to the Engineer and a Progress Meeting held within five days after the end of each 30-day Progress Payment period. Progress Payments are initiated by the Engineer based on the Contractor’s Payment Submittal (as modified at the Progress Meeting review). The

Owner will process the final Progress Payment for payment to the Contractor within approximately 30 days of receipt from Engineer.

No Progress Payment will be finalized by the Engineer until he reviews and approves the DCB.

1.2.04 Substantiation of Progress. Payment Submittals shall reflect progress against the Record Schedule (or Rev. 0 Submittal for the first three Payment Submittals). Refer to the Section on Progress Schedule for more information.

The Contractor is to maintain an updated set of Drawings to be used as record Drawings. As a prerequisite for monthly progress payments, the Contractor is to exhibit the updated record Drawings for review by the Owner and the Engineer.

1.2.05 Final Payment. Fill in application form as specified for progress payments. Use continuation sheet for presenting the final statement of accounting as specified in section on Contract Closeout and Cleaning.

1.2.06 Progress Meetings. Progress meetings shall be held with the Engineer and Owner monthly within five working days after the scheduled payment cut-off-date. One of the primary purposes of these meetings is to evaluate actual Work progress in relation to the Progress Schedule and the Contractor's Payment Submittals.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

End of Section

SECTION 01055

EQUIPMENT RENTAL RATES

PART 1 - GENERAL

1.1 SCOPE. This section describes provisions and general procedures related to determining rates associated with idle equipment or machinery and other contingencies regarding equipment rental rates.

1.1.01 General Conditions of the Contract and Master Specification Section 01180, Equipment, Materials, Parts, and Tools pertain to this Work.

1.1.02 When it is mutually agreed that work has been added to or deleted from the Contract, or the Contractor experiences a compensable delay, it is agreed that the rental rates for equipment or machinery shall be determined as described below.

1.2 GENERAL PROCEDURES. The current edition of the publication entitled, "Rental Rate Blue Book for Construction Equipment" (Blue Book) shall be used to establish the rental rates for each piece of rented machinery or equipment. Dataquest, a company of the Dun and Bradstreet Corporation, 1290 Ridder Park Drive, San Jose, California 95131, publishes the book.

1.2.01 Where leased or rented equipment or machinery is entailed, the rate used to compute payment shall be the actual lease-rental rate or the Blue Book rental rate, whichever is less. The Contractor shall document lease-rental terms. The current edition of the publication entitled, "Contractor's Equipment Cost Guide" shall be used to establish the rental rates for each piece of machinery or equipment owned by the Contractor or a related firm.

1.2.02 In all cases, the equipment rental rates are exclusive of the operator's wages and fringe benefits, but shall include all Owner-related costs defined in the Blue Book. These costs include: purchase price; depreciation; overhead costs such as interest on investments, insurance, property taxes, storage, licensing and record keeping costs; and an allowance for overhaul costs to keep equipment in good operating condition throughout its economic life.

1.2.03 The rental rates allowed herein include the costs of insurance covering the usual insurable risks, including fire and theft. Owner will not be liable for any losses that can be covered by the Contractor's required insurance or for deductible amounts.

1.2.04 The Contractor shall furnish appropriate documentation to the Engineer listing the equipment description, number of actual hours worked each day, total time units, rental rates, and extension (rate times time-units worked) for each unit of equipment engaged. The Contractor's documentation should fully describe each unit of equipment (rating, type of engine, optional equipment, size, manufacturer, model number, type of fuel, horsepower, etc.).

1.2.05 Reimbursement for equipment rental shall cease when the Work Involved is completed.

1.2.06 No rental reimbursement by Owner shall be considered for existing equipment at the site doing Contract Work and not utilized on the extra work.

1.2.07 No rental equipment shall be considered for tools valued at less than $1000, such as hammers, saws, drills, grinders, etc.

1.3 RATE DETERMINATION. For equipment or machinery located at the Work site for Contract Work, but intermittently used to perform extra Work, the hourly rental rate applicable shall be determined by dividing the monthly rental rate by 176. To this base rate shall be added the corresponding monthly-hourly rental rate for any attached equipment (as provided for in the Blue Book Introduction). The sum of these rental rates shall be multiplied by the Area Adjustment Percentage (as defined in the Blue Book Introduction). To that figure shall be added the Estimated Operating Cost per hour (as defined in Article 1.07 of this section). The final sum shall be the Hourly Equipment Rental Rate, exclusive of operator's wages and fringe benefits.

1.3.01 Existing equipment or machinery at the site for Contract Work shall be used for extra work whenever possible.

1.3.02 For equipment or machinery brought to the site specifically to be used on extra work, the hourly rental rate shall be determined basically as defined in Paragraph A above; however, application of these rates shall be determined as follows:

If used on extra work 30 days or more, use the monthly rate;

If used on extra work one week or more, but less than 30 days, use the weekly rate;

If used on extra work less than 7 days, use the daily rate.

1.3.03 Working periods for these calculations shall be considered to be a regular single shift of 8 hours per day, 40 hours per week, 176 hours per month.

1.3.04 Where equipment or machinery is utilized through working periods in excess of the time per period defined in Paragraph D above, the equipment or machinery will be considered as being utilized on overtime. The overtime rate shall be 50 percent of the applicable rental rate. A second or third shift operation shall be considered overtime, unless the equipment or machinery is used only on the additional shift.

1.3.05 Where equipment or machinery is utilized on a monthly or weekly basis and its use is extended only partially into the next period, the base rate shall not increase for the partial period.

1.4 IDLE EQUIPMENT OR MACHINERY. In the event that existing equipment or machinery is idled due to the failure of Owner to properly provide for the Contractor to proceed with the Work in accordance with the Contract, payment may be allowed on a rental basis for the idled equipment. Only existing equipment or machinery idled directly by the extra work shall be eligible for rental reimbursement. For this idled operable equipment or machinery, the Contractor shall receive half the adjusted hourly rental rate, excluding operating cost. Payment will be limited to 8 hours in any one day, 40 hours in any one week, and 176 hours in any one-month.

1.4.01 No payment for idled equipment or machinery shall be made if:

The Contractor suspends the work or removes equipment, machinery, and personnel from the Work that, in the opinion of the Engineer, is necessary for the prosecution of the Work;

The Contractor brings equipment or machinery to the site that is not used and/or required for the Work as determined by the Engineer. Equipment or machinery for standby purposes for which the Contractor wants reimbursement must have the approval of the Engineer prior to delivery to the site;

The Contractor brings equipment or machinery on site before it is required for the Work as determined by the Engineer; or

The Contractor leaves equipment or machinery on site after it is no longer required for the Work as determined by the Engineer.

1.5 OTHER CONTINGENCIES. The following shall apply to all equipment or machinery usage on extra work:

1.5.01 The Estimated Operating Cost per hour includes the following expenses:

All costs for labor and parts for major and minor maintenance, repair and servicing, including but not limited to, repairing, and/or replacing small components such as pumps, carburetors, injectors, motors, gaskets, worn lines, etc.; and

All costs for parts, material, and supplies for operating expendables. This includes fuel, lubrications, filters, oil, grease, and ground engaging components, including tires, pads, blades, bucket teeth, etc.

1.5.02 Owner shall not pay rental reimbursement for transportation vehicles used by officers of the contracting company and their employees to arrive at or depart from the Work site.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

End of Section

SECTION 01060

QUALITY CONTROL

PART 1 – GENERAL

1.1 SCOPE. This section defines minimum requirements for the Quality Control (QC) program to be provided by the Contractor. The deliverable documents are defined, along with the method of execution of the QC program.

The Contractor shall schedule and administer a QC program to ensure an acceptable level of quality for all products and services provided, as evidenced by:

> Engineering design performed under subcontractor agreements with the Contractor.
>
> Firm procedures for transmission of data and information to DWSD and subcontractor, and ensuring the subcontractor's compliance therewith.
>
> Adequate testing and verification to ensure uniform product or services conforming to the design requirements.
>
> Total program surveillance and verification of physical conformance and configuration accountability.

The Contractor's QC program shall meet all requirements herein, as well as ISO Standards 9000 and 9001.

The QC program shall apply to all Work provided under this Contract, including components, equipment, systems, services, software, and construction.

Separate payment will not be made for providing and maintaining an effective QC program, and all costs associated therewith shall be included in the applicable unit prices or lump-sum prices contained in the Contract Price Breakdown.

1.2 GENERAL.

1.2.01 Coordination. After the pre-construction conference, before start of Work, and prior to acceptance by the Engineer of the QC Plan, the Contractor shall meet with the Engineer and discuss the Contractor's QC system. The QC Plan shall be submitted for review a minimum of 14 calendar days prior to the QC Plan coordination meeting.

During the meeting, a mutual understanding of the system details shall be developed, including the forms that will be used to record QC operations, control activities, testing, and administration of the system for both on-site and off-site Work. The interrelationship between the Contractor's management and control and the Owner's control specifications will be defined.

Minutes of the meeting shall be prepared by the Engineer and signed by both the Contractor and the Engineer. The minutes shall become a part of the Contract file. There may be occasions when subsequent conferences shall be called by either party to reconfirm mutual understandings, address deficiencies in the QC system or procedures, and determine corrective actions required by the Contractor.

1.2.02 Governing Standards.

ASTM (American Society for Testing and Materials) D3740 – Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

ASTM E329 – Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

ISO Standard 9000

ISO Standard 9001

1.3 SUBMITTALS. The QC organization shall be responsible for certifying that all submittals are in compliance with the contract requirements.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PLAN. The Contractor shall prepare and furnish a QC Plan for review by the Engineer, not later than 30 calendar days after receipt of Notice to Proceed. The plan shall identify personnel, procedures, controls, instructions, tests, records, and forms to be used. The Engineer will consider an interim plan for the first 30 calendar days of operation. Work will be permitted to begin only after acceptance of the QC Plan or an interim plan applicable to the particular phase of Work to be started. Work outside of the phase of Work included in an accepted interim plan will not be permitted to begin until the QC Plan or another interim QC plan containing the additional phases of Work to be started is approved.

The QC Plan shall include, as a minimum, the following to cover all design and construction operations, both on-site and off-site, including Work by designers, consultants, subcontractors, fabricators, suppliers, and purchasing agents:

A description of the QC organization, including a chart showing lines of authority and acknowledgment that the QC staff shall implement the three phase control system discussed below for all aspects of the Work specified. The staff shall include a QC Officer who shall report to the project manager or executive.

The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function shall be provided to the Engineer.

A copy of the letter to the QC Officer signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the QC Officer, including authority to stop Work which is not in compliance with the Contract. The QC Officer shall issue letters of direction to all other various QC representatives outlining duties, authorities, and responsibilities. Copies of these letters will also be furnished to the Engineer.

Procedures for scheduling, reviewing, certifying, and managing submittals, including those of designers, subconsultants, subcontractors, off-site fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with section on Project Submittals.

Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, phase of Work to be tested, test frequency, and person responsible for each test.

Procedures for tracking preparatory, initial, and follow-up control stages and control, verification, and acceptance tests including documentation shall also be furnished to the Engineer.

Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

Reporting procedures, including proposed reporting formats.

A list of the definable phases of Work. A definable phase of Work is a task, which is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be Work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable phase of Work, there are frequently more than one definable phase under a particular section. This list will be agreed upon with the Engineer.

Acceptance of the Contractor's QC Plan is required prior to the start of Work. Acceptance is conditional and will be predicated on satisfactory performance throughout the Work. The Engineer reserves the right to require the Contractor to make changes in its QC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.

After acceptance of the QC Plan, the Contractor shall notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

3.2 ORGANIZATION. The requirements for the QC organization are a QC Officer and sufficient number of additional qualified personnel to ensure contract compliance. The Contractor shall provide a QC organization which shall be physically available at all times during progress of the Work and with complete authority to take any action necessary to ensure compliance with the Contract. All QC staff members shall be subject to acceptance by the Engineer.

The Contractor shall identify as QC Officer an individual within its organization who shall be responsible for overall management of QC and have the authority to act in all QC matters for the Contractor. The QC Officer shall be a licensed professional engineer or capable of obtaining such license within one year, and have a minimum of 5 years construction experience on construction similar to this Contract. This QC Officer shall be physically available at all times during the execution of Work and shall be an employee of the Contractor. An alternate for the QC Officer will be identified in the plan to serve in the event of the QC Officer's absence. The requirements for the alternate will be the same as for the designated QC Officer.

In addition to QC personnel specified elsewhere in the Contract, the Contractor shall provide as part of the QC organization specialized personnel to assist the QC Officer for the following areas: electrical, mechanical, process, civil, environmental, architectural, and a materials technician. These individuals shall be employed by the Contractor; be responsible to the QC Officer; be physically present during the execution of Work on their areas of responsibility; have the necessary education and experience in accordance with the experience matrix listed herein. These individuals may perform other non-conflicting duties but must be allowed sufficient time to perform their assigned QC duties as described in the QC Plan. Except for the materials technician, each of these individuals shall have a four year college degree from an accredited program in their respective disciplines, and five years of experience in their respective disciplines. The materials technician shall have a minimum of two years of experience.

The Contractor shall maintain its QC staff at full strength at all times. When it is necessary to make changes to the QC staff, the Contractor shall revise the QC Plan to reflect the changes and submit the changes to the Engineer for acceptance.

3.3 IMPLEMENTATION. The QC Plan calls for at least three distinct phases of control to be conducted by the QC Officer for each definable phase of Work.

3.3.01 Preparatory Phase. This phase shall be performed prior to beginning each definable phase of Work, after all required plans, documents and materials are accepted. This phase shall include:

A review of each paragraph of the applicable contract documents.

A review of the contract drawings and construction documents.

A check to assure that all materials and/or equipment have been tested, submitted, and approved.

Review of provisions that have been made to provide required control inspection and testing.

Examination of the Work area to assure that all required preliminary Work has been completed and is in compliance with the Contract.

A physical examination of required materials, equipment, and sample Work to assure that they are on hand, conform to approved shop drawings or submitted data, and are properly stored.

A review of the appropriate activity hazard analysis to assure safety requirements are met.

Discussion of procedures for controlling quality of the Work including repetitive deficiencies. Document construction tolerances and Workmanship standards for that phase of Work.

A check to ensure that the portion of the plan for the Work to be performed has been accepted by the Engineer.

Discussion of the initial control phase.

The Engineer shall be notified at least 48 hours in advance of beginning the preparatory control phase. This phase shall include a meeting conducted by the QC Officer and attended by the superintendent, other QC personnel (as applicable), and the foreman responsible for the Work phase. The results of the preparatory phase actions shall be documented by separate minutes prepared by the QC Officer and attached to the daily QC report. The Contractor shall instruct applicable Workers as to the acceptable level of Workmanship required in order to meet contract specifications.

3.3.02 Initial Phase. This phase shall be accomplished shortly after construction is underway for a definable phase of Work. The following shall be accomplished:

A check of Work underway to ensure that it is in full compliance with contract requirements. Review minutes of the preparatory meeting.

Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.

Establish level of Workmanship and verify that it meets minimum acceptable Workmanship standards. Compare with required samples as appropriate.

Resolve all differences.

Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity hazard analysis with each Worker.

The Engineer shall be notified at least 48 hours in advance of beginning the initial phase. Separate minutes of this phase shall be prepared by the QC Officer and attached to the daily QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

The initial phase should be repeated for each new crew to Work on-site, or any time acceptable specified quality standards are not being met.

3.3.03 Follow-up Phase. Daily checks shall be performed on an ongoing basis to assure control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular phase of Work. The checks shall be made a matter of record in the QC documentation. Final follow-up checks shall be conducted and all deficiencies corrected prior to the start of following Work phases which may be affected by the deficient Work. The Contractor shall not build upon or conceal non-conforming Work.

The Preparatory and Initial Phases shall be re-accomplished as necessary for a phase of Work if the quality becomes unacceptable, the applicable QC staff, on-site production supervision or Work crew changes, Work is resumed after a substantial period of inactivity, or other problems develop.

3.4 TESTS. The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Engineer duplicate samples of test specimens for possible testing by the Engineer. Testing includes operation and acceptance tests when specified. The Contractor shall procure the services of a testing laboratory or establish a testing laboratory at the project site, which is acceptable to the Engineer. The Contractor shall perform the following activities and record and provide the following data:

Verify that testing procedures comply with Contract requirements.

Verify that facilities and testing equipment are available and comply with testing standards.

Check test instrument calibration data against certified standards.

Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

Record results of all tests taken, both passing and failing tests, on the QC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. If acceptable to the Engineer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an off-site or commercial test facility will be provided directly to the Engineer.

Failure to submit timely test reports as stated may result in nonpayment for or rejection of related Work performed.

Materials and equipment used in the performance of Work under this Contract are subject to inspection and testing by the Contractor at the point of manufacture or fabrication. If Work done away from the construction site is to be inspected on behalf of DWSD during its fabrication, manufacture, testing, or before shipment, the Contractor shall give notice to the Engineer of the place and time where such fabrication, manufacture, testing, or shipping is to be done. Such notice shall be in writing and delivered to the Engineer 30 days in advance so that the necessary arrangements for the inspection can be made.

Standard specifications for quality and Workmanship are indicated in the Contract Documents and Construction Documents. The Engineer may require the Contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and Workmanship indicated in the Contract Documents and Construction Documents.

All costs for testing and providing statements and certificates shall be the sole obligation of the Contractor, and no extra charge to DWSD shall be allowed on account of such testing and certification.

3.4.01 Testing Laboratories. Laboratories utilized for testing soils, concrete, asphalt, and steel shall meet criteria detailed in ASTM D3740 and ASTM E329.

3.4.02 On-Site Laboratory. The Owner reserves the right to utilize the Contractor's control testing laboratory and equipment to make assurance tests and to check the Contractor's testing procedures, techniques, and test results at no additional cost to the Owner.

3.4.03 Transportation of Samples for Testing. Costs incidental to the transportation of samples or materials will be borne by the Contractor. Samples of materials for test verification and acceptance testing by the Engineer shall be delivered to the Engineer.

3.4.04 Independent Testing Laboratories. In addition to testing performed by the Contractor, the Engineer may retain the services of an Independent Testing Laboratory (ITL) to perform additional testing, and may at any time elect to have materials and equipment tested for conformity with the Contract Documents.

The Contractor shall cooperate with the Engineer and the Laboratory to facilitate the execution of its required services.

Employment of the ITL shall in no way relieve Contractor's obligations to perform testing, QC, and all other aspects of the Work of the Contract.

ITL’s are not authorized to release, revoke, alter or enlarge on requirements of Contract Documents; approve or accept any portion of the Work; or perform any duties of the Contractor.

3.4.05 Contractor’s Responsibilities in Support of ITL's. Contractor shall cooperate with ITL personnel and provide access to Work or Manufacturer's operations.

Contractor shall secure and deliver to the ITL, adequate quantities of representative samples of proposed materials that require testing.

Contractor shall provide to the ITL, the preliminary design mix proposed to be used for concrete and other materials that require control by a testing laboratory.

Contractor shall furnish incidental labor and facilities to provide access to Work-to-be-tested; obtain and handle samples at the Project site or at the source of the product to be tested; facilitate inspections and tests; and store and cure samples.

Contractor shall notify the Engineer sufficiently in advance of operations to allow for ITL assignment of personnel and scheduling of tests. When tests or inspections cannot be performed due to inadequate notice, Contractor shall reimburse DWSD for ITL personnel and travel expenses incurred due to Contractor's negligence.

The Contractor is deemed to have included in its bid price sufficient monies for furnishing incidental labor, equipment, materials and facilities necessary to support all ITL services.

If the tests and any subsequent re-tests indicate the material or equipment fail to meet the requirements of the Contract Documents, the Contractor shall be liable to DWSD for the ITL costs as well as the cost to remove and replace or repair the substandard materials or equipment.

3.5 COMPLETION INSPECTION.

3.5.01 Final Completion Punch List. Near the completion of all Work, or any portion of Work for which a separate final completion is specified, the QC Officer shall conduct an inspection of the Work and develop a "punch list" of items which do not conform to the approved drawings and specifications. Such a list of deficiencies shall be included in the QC documentation below, and shall include the estimated date by which the deficiencies will be corrected. The QC Officer or staff shall make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished the Contractor shall notify the Engineer that the facility is ready for the Engineer’s final inspection.

3.5.02 Final Inspection and Acceptance. The Contractor's QC Officer and the Engineer will be in attendance at this inspection. Additional Engineer personnel may also be in attendance. The final acceptance inspection shall be formally scheduled by the Engineer when all punch list deficiencies have been corrected. Notice shall be given to the Engineer at least 14 days prior to the final inspection and must include the Contractor's assurance that all punch list items will be complete and acceptable by the date scheduled for the final inspection. Failure of the Contractor to have all Contract Work, or any portion of Work for which a separate final completion is specified, completed for this inspection, shall be cause for noncertification of final payment by the Engineer.

3.6 DOCUMENTATION. The Contractor shall maintain current records providing factual evidence that required QC activities and tests have been performed. These records shall include the Work of designers, subconsultants, subcontractors, and suppliers and shall be on an acceptable form that includes, as a minimum, the following information as applicable:

Contractor, designer, consultant, subcontractor and their area of responsibility.

Operating plant/equipment with hours worked, idle, or down for repair.

Work performed each day, giving location, description, and by whom. Identify each phase of Work performed each day by activity number. Indicate the trades and number of personnel working on the project; weather conditions encountered; and any delays encountered.

Test and control activities performed with results and references to specifications/drawings requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.

Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications and drawings requirements.

Submittals reviewed, with contract reference, by whom, and action taken.

Off-site surveillance activities, including actions taken.

Job safety evaluations stating what was checked, results, and instructions or corrective actions.

Instructions given and received and conflicts in plans and specifications.

Contractor's verification statement.

These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the Work and Workmanship comply with the contract.

The original and one copy of these records in report form shall be furnished to the Engineer daily within one Work day after the date(s) covered by the report. During periods when no work is being performed, a report shall be prepared and submitted for every seven days that no Work occurs on the last day of each no Work period. All calendar days shall be accounted for throughout the life of the contract. The first report following a day of no Work shall be for that day only. Reports shall be signed and dated by the QC Officer. The report from the QC Officer shall include copies of test reports and copies of reports prepared by all subordinate QC personnel.

Contractor shall provide copies of all QC reports, results and records as requested by the Engineer.

A complete set of indexed QC reports shall be provided to the Engineer within 60 days after Certification of Substantial Completion is submitted and all reports shall be filed in cabinets in ascending order. Three complete sets of indexed QC reports shall be submitted to the Engineer within 60 days.

3.7 NOTIFICATION OF NONCOMPLIANCE. The Engineer will notify the Contractor of any detected noncompliance with these requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

End of Section

SECTION 01070

PROJECT COORDINATION AND MEETINGS

PART 1 - GENERAL

1.1 SCOPE. This section specifies the requirements of the Contractor to coordinate Work with other construction projects at other DWSD facilities, and with all other jurisdictional authorities involved in the Work as applicable. The Contractor shall also coordinate work with DWSD operation and maintenance activities at the site.

Certain meetings are also defined in this section that need to be held on a recurring basis to track progress, resolve problems, and coordinate work.

1.2 GENERAL.

1.2.01 Coordination. The Contractor shall cooperate with DWSD and Engineer in allocation of mobilization areas onsite for field offices and sheds, access, traffic, storage areas and parking facilities.

Comply with the Engineer's procedures for inter and intra-project communications to include submittals, reports, records, schedules, coordination drawings, recommendations, and resolution of ambiguities/conflicts.

Coordinate field engineering and layout work under instructions of Engineer.

Coordinate scheduling, submittals and work of the various sections of Contract Documents to insure orderly sequence of development, design, and installation of construction activities.

Coordinate sequence of Work to accommodate DWSD or Owner occupancy as specified in General Conditions.

In addition to Progress Meetings, hold pre-construction conferences and Coordination Meetings with personnel and sub-contractors to assure coordination of Work. The Engineer shall be informed of such and shall be allowed to attend.

Coordinate the work of various sections having interdependent responsibilities for installing equipment, connecting equipment, and placing such equipment in service.

Coordinate use of project space and sequence of civil, architectural, mechanical, structural, instrumentation, systems and electrical installation work. Follow available physical space during routings for pipes, ducts, and conduits. Runs shall be parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, maintenance, and repairs.

Coordinate substantial work completions, including corresponding field performance certification testings, cleanings and other elements of such work in preparation for acceptance.

After DWSD occupancy of premises, coordinate work in existing facilities to minimize disruption of DWSD's operations. Coordinate access to site for correction of defective work.

1.3 PROJECT MEETINGS. Project meetings shall be held as specified herein to review project progress, to ensure correct interpretation of these documents, and to maintain general coordination of DWSD's personnel to Contractor's project personnel. The agenda will serve to indicate which project members should be present at each meeting.

1.3.01 Preconstruction Conference. Following Contract award, the Engineer will schedule a preconstruction conference.

Attendees shall include the Owner or his representative, Engineer or his representatives, Design Consultant(s), Inspectors, Contractor, Superintendent, subcontractors, suppliers, utilities, and others as appropriate.

The suggested Agenda should address the following issues at a minimum:

Letters for Notice to Proceed, Designated Engineer by DWSD, and Field Engineer/Representative.

Distribution and discussion of major subcontractors and suppliers (furnish list).

Projected construction schedules including mobilization and detailed schedule for first two weeks.

Regulatory requirements affecting the Project.

Critical work sequencing and related concerns.

Major equipment deliveries and priorities.

Designation of personnel responsible for project coordination.
Procedures for and processing of field decision, proposal requests, submittals, change orders, and applications for payment.

Adequacy for distribution of Contract documents.

Questions regarding Contract documents.

Procedures for maintaining record documents, samples and manuals.

Use of premises for office, work and storage areas, and Owner’s requirements.

Construction facilities, control and construction aids.

Temporary utilities.

Security and housekeeping procedures.

Check of required bond and insurance certifications.

Liquidated damages.

Request for a monthly job meeting for all involved.

Equal opportunity requirements.

Procedures for laboratory testing of material requirements.

Inventory of material stores on site provisions.

Posting of Government funding sign.

Owner’s requirements for occupancy.

Requirements for start-up of equipment.

Inspection, acceptance and warranties of equipment put into service during construction period.

Project close-out requirements.

Safety and first-aid procedures.

Any other appropriate items or subjects that require the attention and attendance of the Contractor and major subcontractor prior to commencing construction.

1.3.02 Progress Meetings. The Engineer will schedule and administer monthly progress meetings throughout progress of the Work within five working days after the scheduled payment cut-off date. More frequent progress meeting may be required

should the contractor fall behind schedule. The Engineer will prepare agenda, preside at the meeting, record minutes, distribute notice of each meeting to participants, four working days in advance of meeting date and deliver copies of the minutes to participants after the meeting.
Meetings shall be held at the Contractor's field office. The contractor shall provide adequate facility to accommodate a minimum of fifteen (15) people.

Attendance for the Progress Meetings shall include the Contractor, project superintendent, subconsultants, sub-contractors, suppliers, Engineer, job site inspectors, and professional consultants as appropriate.

Suggested Agenda:

Review and approval of minutes of previous meeting.

Discuss safety, problems, conflicts, and comments.

Review of work progress since previous meeting.

Discuss field observations, problems and conflicts.

Discuss problems which impede construction schedule.

Review of off-site fabrication and delivery schedules.

Discuss corrective measures and procedures to regain project schedule.

Discuss revisions to construction schedule.

Discuss progress and schedule during succeeding work period.

Coordinate schedules.

Review submittal schedules, expedite as required.

Discuss maintenance of quality standards.

Discuss pending changes and substitutions.

Review proposed changes for effect on construction schedule, completion date, and other contracts.

Discuss other business.

Discuss construction schedule and CPM network.

Discuss critical/long lead items.

The contractor shall be prepared for progress meetings and ready to discuss pertinent topics such as current agenda items, previous meeting minutes, materials deliveries, equipment, and work progress.

The Contractor shall provide a current submittal log at each progress meeting in accordance with Section Project Submittals.

The Contractor shall prepare and submit a 3 week look-ahead schedule in bar chart format for each progress meeting. The look-ahead schedule shall address specific construction activities planned for the succeeding three week period with emphasis on operations involving tie-ins to existing facilities, interference with plant operations and coordination with other construction contracts.

The Contractor shall prepare a brief written narrative report relating to the status of construction, submittals, approvals and procurement. This report shall indicate areas where any problems exist or are anticipated, and shall prescribe action required by the Owner, Engineer, or Contractor.

1.3.03 Coordination Meetings. The Engineer will schedule and administer coordination meetings as needed whenever the workload or progress of the work requires additional coordination effort.

The Engineer will prepare the agenda, preside at the meeting, record minutes and distribute copies after the meeting to participants.

Attendees shall include the Contractor, project superintendent, consultants, subcontractors, suppliers; Engineer, Engineer’s representatives and consultants as appropriate.

The Engineer will determine the agenda for each coordination meeting on a case by case basis. Typical issues that may be included are:

Approval of minutes of previous Project Coordination Meetings.

Resolution of problems that impede planned progress.

Review the interpretation of the Contract Documents to ensure correct compliance.

Review change order status.

Review progress payments.

Review Project Schedule for completed and upcoming milestones.

Review cost impact of potential contract changes.

Review meeting minutes from Progress Review Meetings.

Review program management and implementation.

1.3.04 Coordination Drawings. Provide information required by the Engineer for preparation of coordination drawings.

1.3.05 Pre-Installation Conferences. Contractor shall convene pre-installation conferences at work sites prior to commencing new phases of the Work. Attendance is required from entities directly affecting, or affected by Work. Notify Engineer five working days in advance of meeting date. Prepare agenda, preside at conference, record minutes, and distribute copies within one week after conference to participants, with two copies to Engineer. Review conditions of installation, preparation and installation procedures, and coordination with related Work.

1.4 SUBMITTALS. Submit requests for interpretation of Contract Documents in a timely fashion to ensure no disruptions with the Work as scheduled. Obtain instructions through the Engineer to resolve all queries.

Comply with DWSD's instructions for completion of items of Work found incomplete in the Engineer's final inspection.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

Not used.

End of Section

SECTION 01080

PROJECT SUBMITTALS

PART 1 - GENERAL

1.1 SCOPE. The Contractor shall prepare and manage submittals in accordance with this section and Article 4.8 – “Shop Drawings, Product Data and Samples” of the General Conditions (Exhibit C) of the Agreement.

1.2 GENERAL.

1.2.01 Overview. Submittals are required documents or products that must be submitted to the Engineer for review by the Contractor before construction or a facet of construction, equipment installation, or related activity can proceed.

Submittals fall into two main categories. The first category consists of administrative plans that show how the Contractor will manage various aspects of the construction process. These submittals are submitted early in the process before construction has progressed very far. The second category consists of technical submittals that include shop drawings, product data, certifications, samples, test reports, and mock-ups. Technical submittals provide detailed information on the actual construction of the project or installation of specific equipment.

The Contractor shall not proceed with the fabrication, procurement of equipment, procurement of materials, or facility modifications, until submittals have been reviewed and approved by Engineer. The Contractor shall be responsible for and bear all cost of damages which may result from ordering any materials or proceeding with any part of work prior to the completion of the review of necessary submittals by the Engineer.

The Engineer's approval will be for the purpose of minimizing changes and project delays in the field, and shall in no way relieve the Contractor of full responsibility for providing a complete, safe, reliable, operating and fully coordinated project (system/ equipment/facilities) which is in compliance with these contractual documents.

1.3 SUBMITTALS.

1.3.01 Administrative Submittals. The Contractor shall submit to the Engineer the applicable administrative documents listed below:

Certifications

Project Management Plan
Project Control Reports

Subcontractor Consent Requests

Progress Schedule

Schedule of Values and Detailed Cost Breakdown

Training Plan

Safety Plan

Confined Space Entry Plan

Progress Payment Requests

Cost Forecasts

Bonds

Insurance Policies

Quality Control Plan

Test and Inspection Reports

Minutes of Design Review Meetings

Daily Field Inspection Reports

Construction Photographs

Affidavits of compliance with City of Detroit withholding tax requirements.

These documents are described in more detail in the General Conditions and other Division 1 Specifications.

1.3.02 Product Information and Performance Data. The Contractor shall submit product documentation to Engineer. The information shall cover all items as called for in the Contract Documents. The submittal information shall show the standard and optional product features, as well as all performance data and specifications. Drawing and schedule submittals shall be checked and coordinated with the work of all trades involved before they are submitted for review by the Engineer. All submittals shall bear the Contractor's stamp and approval as evidence of such checking and coordination. Submittals without this stamp of approval shall be returned to the Contractor for resubmission. Approval of the Contractor's documents by Engineer shall not relieve the Contractor of the responsibility to meet all the requirements of the Contract Documents.

1.3.03 Software and Firmware Submittal. The Contractor shall submit complete documentation on the operation and use of all software and firmware contained in equipment furnished under this Contract. All software and firmware shall be supported by the Contractor for at least five (5) years after Engineer acceptance of all work. The Contractor shall also submit licensing in the name of the Engineer (City of Detroit, Water and Sewerage Department) for all purchased software packages and all software and firmware developed for the Engineer. The Contractor shall submit source code, documentation, editor and warranty for all developed software.

1.3.04 Preliminary Submittal List. Within thirty (30) calendar days after Notice to Start Work, the Contractor shall submit to the Engineer a complete list of preliminary submittal data for this contract. Included in this list shall be the names of all proposed manufacturers furnishing specified items. Review of this list by the Engineer shall in no way, express or implied, relieve the Contractor from submitting complete Shop Drawings in accordance with the Specifications. This procedure is only required to expedite review of Shop Drawings.

1.4 REQUIREMENTS AND FORMAT OF SUBMITTALS.

1.4.01 Drawing Format and Media. Refer to Master Specification Section 01020, Documentation Standards for drawing format and media.

1.4.02 Shop Drawings. Shop drawings shall convey, or be accompanied by, calculations or other sufficient information to completely explain the structure, machine, or system. Prior to commencing such work, shop drawings must have been reviewed without specific exception by the Engineer. Review will be for general conformance and will not relieve the Contractor in any way from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor.

Submit a minimum of 10 hard copies plus the number of copies required by the Contractor and one electronic copy of each shop drawing to DWSD/Owner's Representative for review and approval. Detailed calculations for the shop drawings shall be stamped by a registered Professional engineer in the State of Michigan

1.4.03 Working Drawings. When used in the Contract Documents, the term "Working Drawings" shall be considered to mean the Contractor's plans for construction activities. Construction activities include but are not limited to temporary structures, support of open cut excavation, support of utilities, ground water control systems, forming underpinning and for such other work as may be required for construction but does not become an integral part of the Project.

Working drawings shall be signed and sealed by a Registered Professional Engineer, currently licensed to practice in the State of Michigan. The drawings shall convey, or be accompanied by, calculations or other sufficient information to completely explain the structure, machine, or system described and its intended manner of use. Prior to commencing such work, working drawings must have been reviewed without specific exception by the Engineer. Review will be for general conformance and will not relieve the Contractor in any way from his responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor.

Submit a minimum of 5 copies to DWSD or Engineer, and 6 copies plus the number of copies required by the Contractor to the Owner's Representative of each shop drawing for review and approval.

1.4.04 Product Data. Product data shall include all catalog cuts, performance curves, test reports, equipment lists, material lists, diagrams, pictures, and descriptive material. All product data shall be submitted on either 8.5 x 11 inch (216 mm x 279 mm) or folded 11 x 17 inch (279 mm x 432 mm) size paper of 20 lb. weight. The product information shall cover but is not limited to all items including mechanical devices, mounting components, wiring, terminal strips, connectors, accessories, and spare parts. The submittal information shall show standard and optional product features, as well as performance data and specifications. The product information described in Subsection 1.4.12 below shall be marked on all product data sheets. Do not submit general catalogs; only items to be installed or delivered.

Submit a minimum of 5 copies to DWSD or Engineer, and 6 copies plus the number of copies required by the Contractor to the Reviewer of each product information data sheet for review and approval.

1.4.05 Samples. The Contractor shall furnish, for approval of the Engineer, any samples required by the Contract Documents or requested by the Engineer. Samples shall be delivered to the Engineer as specified or directed.

All samples shall be of sufficient size and quantity to clearly illustrate the functional characteristics of the product, with integrally related parts and attached devices. The samples shall show the full range of colors, textures and patterns.

A minimum of 2 samples to DWSD and 2 sample to the Reviewer/Engineer of each sample product submitted for review and approval. All samples shall be marked with required submittal information, as required in Article 1.4.12 below. The materials or equipment of which samples are required shall not be used in the work until approved by the Engineer.

1.4.06 Color, Texture and Pattern Charts. The Contractor shall submit color texture, or pattern charts of all required finishes.

A minimum of two (2) charts to DWSD or Engineer, and two (2) charts to the Reviewer of each product chart submitted for review and approval.

1.4.07 Final Record (As-Built) Drawings. The Contractor shall submit the Final As-Built Drawing Package to the Engineer for review and approval 60 days after project elements or system acceptance by the Engineer. The Final As-Built Package shall contain two (2) reproducible mylars and six (6) black lines on 20 lb. bond paper. Refer to Master Specifications Section 01190, Contract Closeout and Cleanout for additional information. The as-builts need to be sized D drawings and in electronic format.

1.4.08 Operation & Maintenance Manual. The Contractor shall submit to Engineer, for approval, manufacturer's installation, operation, lubrication, maintenance & training manuals for all equipment installed or delivered under contract.

1.4.09 Manufacturer Instructions. Submit the manufacturer's instructions for storage, installation, adjustment, etc. as required elsewhere in the Specifications for the individual items.

1.4.10 Equipment Listing. Submit an equipment listing including each specified item, the manufacturer's name and model No., and any additional information regarding options, ratings, sizes, etc. Organize the list in order of specification section.

1.4.11 Certified Tests. Submit certified results of the tests, specified elsewhere, on the individual items/systems.

1.4.12 Submittal Information Requirements. When used in the Contract Documents, the term "Submittal Information" shall be considered to mean the following information:

Contract Name.

Contract Number.

Plant, Station or Location Name.

Location within facility.

Date Submitted.

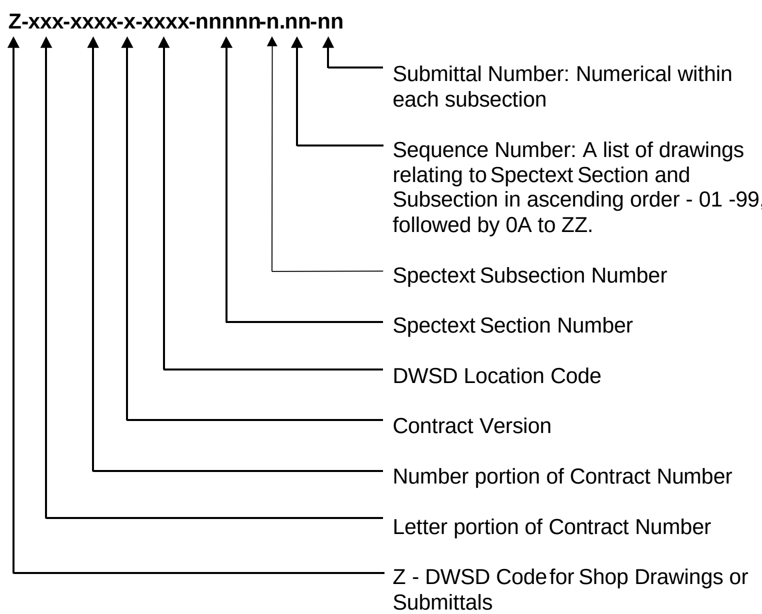
Spectext Section and Subsection Number.

DWSD Z-file Number.

The Contractor shall mark submittal information on all drawings in the area provided in the left half of the 6 inch x 3 inch (15.2 cm x 7.6 cm) block.

The Contractor shall mark all product data and manufacturer's literature with the submittal information, and note what item is being furnished. The Contractor shall mark what option and supplies are being furnished with each item. At least one original manufacturer’s product data sheet must be submitted, the balance can be copies. Do not submit manufacturer's general catalogs, submit only items being installed or delivered. When manuals are being submitted, the Contractor shall mark submittal information on both the cover and title page. If the manual being submitted contains more than just one item, each item must be marked, and only the contract name and number shall be marked on the cover title page.

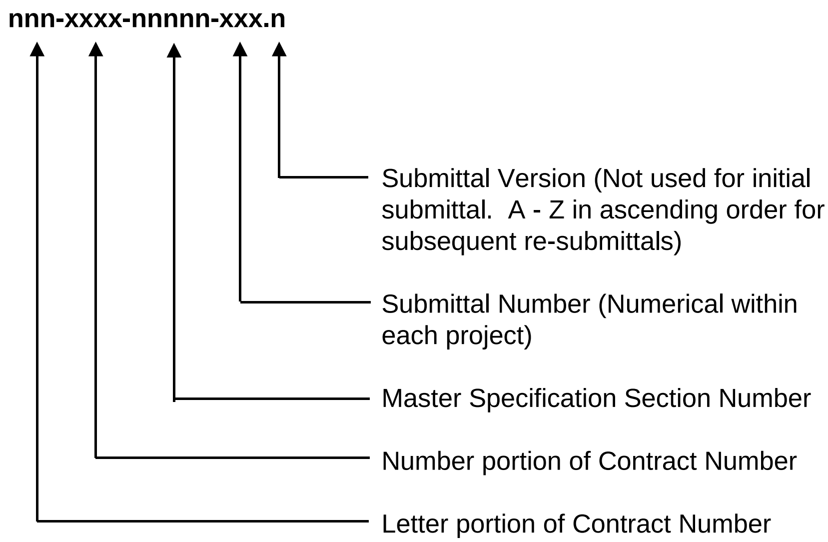
1.4.13 <u>DWSD Z-file Format</u>. DWSD Z-File format shall be identified on each submittal by Contractor to DWSD for review.



<u>Example</u>: Z-WWO-0533-0-S001-15100-2.03-06

This is the information required for gate valves submitted as specified on page 15100-3 of Contract No. 533. The last two digits (06) represent the sixth submittal for that subsection to be submitted.

1.4.14 <u>Streamlined DWSD Submittal Format</u>. With the approval of the Engineer, the Contractor shall use the following streamlined format to identify and track submittals. The submittal identification must be included on all submittals provided by the Contractor to the Engineer for review.



Example: WWO-0533-15104-018

This is the information required for resilient-seated gate valves submitted as Submittal No. 18 under Contract No. WWO 533. The gate valves submitted are specified under Master Specification Section 15104. This is the first submittal so no alphanumeric suffix is shown. If the Engineer requires the submittal to be amended and resubmitted, the Contractor will resubmit as WWO-0533-15104-018.A.

1.4.15 Submittal Quality: All submittals shall be submitted in a readable and legible quality. Any submittal which the Engineer considers not of acceptable quality will be returned to the Contractor for replacement without review.

Facsimile (fax) transmittals or copies of fax transmittals are not acceptable as submittals.

Xerographic copies must be of good quality (3rd generation copy shall be clear and legible) and at least one copy of manufacturer’s original product data sheets must be included with each submittal. All copies shall be on 20 lb (9.1 kg) white bond paper.

1.5 SCHEDULES. The Contractor shall prepare and maintain all schedules required by the Contract Documents and submit schedules for review and approval in appropriate format.

1.5.01 Construction Progress Schedules. The Contractor shall submit a construction progress schedule with separate items for each operation, identifying the first day of work.

A complete sequence of construction, identifying work of separate stages and other logical groups together shall be shown on the schedule.

The Contractor shall submit a projected percentage of completion for each item of work at the time each progress payment is submitted.

The Contractor submittal dates shall be marked on all shop drawings, product data, samples, schedules, and shall include projected product delivery dates.

The Contractor shall submit for approval a network analysis system using critical path method, as outlined in AGC publication "The Use of CPM in Construction - A manual for General Contractors".

1.5.02 Schedule of Equipment. On approved software application, the Contractor shall submit on both paper and disk a schedule of all major components and subsystems installed or delivered under this contract. The schedule shall be compiled with approved software application and shall include the name of the item, manufacturer, a model number, serial numbers, location, and function. The Contractor shall submit the schedule to the Engineer for approval, and final copy shall be submitted with the project record documents and software.

1.5.03 Schedule of Valves. On approved software application, the Contractor shall submit on both paper and disk a schedule of all valves installed or serviced under this contract. The schedule shall be compiled with an approved software application and shall include manufacturer, model, type, pressure rating, location, and type of operator.

1.5.04 Schedule of Instruments. On approved software application, the Contractor shall submit on both paper and disk a schedule of all instruments installed, serviced, modified or replaced under this contract. The schedule shall be compiled with an approved software application and shall include manufacturer, model, type, instrument range, location, and function.

1.6 SPECIFIC SUBMITTAL REQUIREMENTS BY DIVISION. The Contractor shall submit for review and approval all specified product data sheets, catalog cuts, manufacturers' manuals, and all other items which would affect the performance or operation of the equipment or system.

1.6.01 Process Instrumentation and Control Submittals. The Contractor shall submit all process instrumentation and control data to ensure contractual compliance with the requirements of the contract. The submittals shall include support system testing, installation instructions, integration, and system acceptance testing, beginning with the factory acceptance and continuing through the final system acceptance.

Instrument Loop Diagrams: The Contractor shall provide diagrams for all discrete loops, with special emphasis on device elements and their functions to provide understanding of the operation, maintenance, and troubleshooting.

Connection Diagrams: The Contractor shall provide connection diagrams showing component arrangement and internal wiring between devices.

Interconnection Diagrams: Interconnection diagrams shall be provided by the Contractor for all field wiring and wire codes.

Process and Instrumentation Diagrams: The Contractor shall provide diagrams showing all existing and new instrumentation.

Ladder Diagrams: The Contractor shall provide ladder logic diagrams for all logic control circuits.

Panel Detail Drawings: The Contractor shall provide detailed drawings for all panels provided. These drawings shall include all panel mounting devices, and all interior equipment and wiring.

Instrumentation Schedules: The Contractor shall submit instrument schedules for all instruments.

Product Data: The Contractor shall submit the following instrumentation and control product data.

Material Data Sheets.

Instrument Data.

Component Fabrication Drawings.

Test Procedures.

Test Reports.

Operation and Maintenance Manuals.

Final and As-Built Documentation: The Contractor shall submit for review and approval, all final revisions of documentation under this contract.

Test and Acceptance Documentation: The Contractor shall submit for review and approval, the Test and Acceptance Documentation.

Training Documentation: The Contractor shall submit for review and approval, all Training Documentation, consisting of all outlines for training classes and complete training manuals for all levels and types of personnel requiring training. All training manuals and documentation shall become part of the O & M Manuals, as specified in section on Training and Operations & Maintenance Manuals.

Interface Information. The Contractor shall submit an interface table, which describes all external interfaces to and between the Contractor's equipment. Include facilities, communication protocols, voltages, impedances, polarities and existing equipment.

1.6.02 Architectural and Civil Submittals. This section specifies general procedural requirements for contractual submittals for the following architectural and civil schedules, drawings, product data, samples and manufacturer's certificates.

Architectural Drawings: The Contractor shall provide architectural layouts and plans, with special emphasis on elements and their functions, to provide better understanding of the operation and maintenance of the system. The drawings shall include site plan, floor plans, elevations, sections and details.

Structural Drawings: The Contractor shall provide structural and miscellaneous metal drawings showing foundations, mounting components, fasteners, arrangements, and structural details.

Product Data: The Contractor shall submit product data for all architectural, structural, options and other data. Contractor shall provide supplemental manufacturer's standard data for information unique to the work and installation. The submittals shall reflect all items delivered or installed under this contract.

Samples: The Contractor shall provide to the Engineer all samples required under this specification including color charts and product samples.

1.6.03 Mechanical and Electrical Submittals. This section specifies general procedural requirements for contractual submittals for the following mechanical and electrical submittals. Include product data, performance data, control diagrams and other mechanical submittals.

Floor Layout Drawings: The Contractor shall submit floor layout drawings for all mechanical equipment, piping and electrical equipment. Include location dimensions for all connections, oil supply, electrical, power, controls and status connections. The base dimensions and weights shall also be provided.

Composite Assembly Drawings: The Contractor shall provide composite assembly drawings for all mechanical equipment, piping and electrical equipment. Show locations of all auxiliary equipment, dimensions and weight.

Pipe Layout and Drawings: The Contractor shall submit as follows but not limited to installation drawings for pipes, valves, fittings, sewers, drains, heating ducts, ventilation ducts, electrical, plumbing lines, electrical cable trays, lighting fixture layouts, circuiting, instrumentation, interconnection wiring diagrams, communications, power supply, alarm circuits, etc., under this Contract. The final dimensions may depend upon the dimensions of equipment and valves to be furnished by the Contractor.

Elevations: The Contractor shall provide elevation drawings for all mechanical and electrical equipment including front, rear, and side views. Drawings shall include diagrams for nameplates, control panels, component placement and alignment.

Specification Sheets: The Contractor shall submit specification sheets with performance data and engineering details for all mechanical and electrical units installed under this contract. Specification sheets shall determine adequate compliance with the contractual requirements.

Electrical Interconnection Diagrams: Contractor shall submit electrical interconnection diagrams including motors, control panels, pressure, switches level switches, motor control circuits, motorized actuators, and I/O contractual requirements.

Component Identification: The Contractor shall submit a complete identification list of all mechanical and electrical components, materials, manufacturer, model number, rating and serial number.

Performance Data: The Contractor shall submit complete mechanical and electrical unit/subsystem performance data.

Power and Riser Diagrams: The Contractor shall submit single line power and riser diagrams for all equipment and facilities.

Wiring Diagrams: The Contractor shall submit for review and approval a complete set of wiring diagrams. The drawings shall include elementary control diagrams and separate wiring diagrams for mechanical and electrical units or subsystems. Drawings for the starting and shutdown of equipment, including, controls shall be provided. A comprehensive description of operation shall be provided.

Finish Data: The Contractor shall provide complete surface preparation and finish data for all mechanical and electrical units or subsystems including a complete list of cleaning instructions.

Factory Testing: A detailed description of factory testing procedures, reporting procedures, and criteria for the test shall be provided for all mechanical and electrical equipment as specified in each appropriate specification. After fabrication and testing the results of all tests shall be submitted to Engineer. No shipment of any mechanical and electrical equipment shall be allowed without written permission from the Engineer.

Field Testing and Acceptance: The Contractor shall submit for review and approval detailed descriptions of all site or field testing and acceptance. Include descriptions of procedures, test equipment, reporting procedures and criteria for testing all mechanical and electrical equipment.

Operations and Maintenance Manuals (O & M): The Contractor shall furnish manuals for all mechanical and electrical equipment specified under this contract. Each manual shall include complete sets of drawings, description of equipment, record shop drawings, O & M instructions, parts lists, equipment ratings, valve list, lubrication instructions, description of periodic maintenance required, description of trouble shooting procedures, list of replacement parts and any other additional information which may be needed to operate and maintain the equipment. No equipment system will be approved without prior submittal and approval of O & M Manuals.

1.7 CONTRACTORS REVIEW. Coordinate the timely submittal of all necessary information to keep the project on or ahead of schedule. All drawings, product data, lists, samples, test reports, manuals, and other required information shall be submitted in sufficient time to allow the Engineer twenty (20) to forty five (45) days of review time. The submittal review process includes any necessary correlation and checking of related and interdependent parts of the work. Scheduling of submittals shall allow time for review, correction, resubmittal, and final review prior to the ordering of equipment, fabrication of materials, or actual construction, assembly, or erection. No claim for extra cost, damage, or extension of time shall be made because of a failure to submit said information sufficiently in advance.

Submit information on all portions of the work irrespective of their being specifically mentioned.

Review submittal prior to transmitting to the Engineer. Check the completeness of the information submitted. Verify field measurements, coordination of all component parts of work, conformance of all materials, methods, and equipment to Contract Documents. Stamp, sign, and date acceptable submittals before transmitting to the Engineer.

Do not perform any work covered by submittal(s) prior to approval of all related submittals by the Engineer.

No claim shall be made for costs incurred, damages or extension of time required to modify or replace any equipment, materials, or structures in order to conform to submittals as approved by the Engineer.

No alterations shall be made to drawings previously approved by the Engineer without his written consent.

1.8 RESUBMITTALS. Make resubmittals under the same procedure specified for initial submittals.

Verify that all corrections, equipment/system coordination, and field verifications required by Engineer during the initial review have been made, all additional information requested has been supplied, and any other comments made by the Engineer have been addressed in the resubmittal.

Identify all changes made on the submittal since the previous review. Designate drawings with a revision number; letter and the date revised.

1.9 SCHEDULE OF SUBMITTALS. Prepare a Schedule of Submittals as shown on the following page unless another format is pre-approved by Owner.

Submit all of the indicated shop drawings, product data, manufacturer's instructions, equipment part lists, samples, certified test reports, O&M manuals and other items as required on the schedule or in each detailed Specification Section. The sample Schedule of Submittals on the following page shows a few limited examples of entries in a typical schedule of submittals. The Contractor must review each section of the Contract Documents for all required submittals and identifying them by CSI division in the project Schedule of Submittals. The Contractor shall maintain a schedule of submittals on Owner approved software application. The schedule shall include the Name of Items or Subsections, Size and Type, Manufacturer Name, Part No., Drawing Number, Date Submitted, DWSD Z-file Number, DWSD Approval Date, and Approval Status.

A copy of the schedule of submittals, both on paper and disk, shall be submitted to the Engineer at each monthly progress meeting. Three copies of both paper and Owner approved software data files shall be submitted to the Engineer within 5 working days of Substantial Completion.

Submittal Schedule for Project (List No and Title)
as of (Date)

Section	Submittal Type	Item Description	Submit No	Date Due to Engineer	Date to Engineer	Date from Engineer	Action Taken	Comments
02539		**Sanitary Sewage Systems**						
		Subcontractor: (List Company, Contact, and Phone)						
	Product Data	Pipe						
	Product Data	Manholes						
	Certification	Manufacturer's Certification, Pipe						
	Shop Drawings	Sheeting and Bracing Plan for Jacking Pits						
03300		**Concrete**						
		Subcontractor: (List Company, Contact, and Phone)						
	Product Data	Concrete Design Mix						
	Product Data	Concrete Admixtures						
	Product Data	Grout						
	Product Data	Chemical Hardner						
	Test Report	Aggregate quality and gradation						
	Test Report	All Laboratory Tests						
	Certification	Type and amount of fly ash used						
	Shop Drawings	Concrete slabs or beams exceeding 20 feet span with vertical supports exceeding 6 feet						

General: The Schedule of Submittals is a management tool to make sure that all the issues requiring review of materials, shop drawings, etc. are tracked and managed to ensure the finished product is safe, meets specifications, and fulfills the intent of the project. Subcontractors may want to expand this Schedule to allow tracking to and from subcontractors, etc. This is the minimum information that needs to be submitted to the Engineer initially and at on-going progress meetings.

Submittals Types: Shop Drawings, Product Data, Certifications, Samples, Test Reports, Mock-ups, and Record Drawings.

Item Description: Within each Specification Section, there will be many different materials requiring some sort of submittal. Each material should be listed. Within each submittal type, there may be many subcategories.

Use this area to provide more detail if needed. For example, under product data, for a line item, you may want to list Manufacturer's Installation Instructions.

Submittal Number: Submittal numbers are assigned sequentially beginning with 1 and running as necessary to cover all submittals. If a submittal requires revision and resubmittal, the submittal will use the original submittal number followed by a letter (A,B,C,…). For example, if Submittal No. 347 requires resubmittal, the first revised submittal would be Submittal No. 347A and should be inserted into Submittal Schedule in row directly under Submittal No. 347.

Date Required to Engineer: The Engineer needs 20 to 45 days to review submittals depending on complexity. Different materials have different lead times for ordering. Based on the construction schedule, the specific date a submittal needs to be in to the Engineer to keep on schedule should be identified in this column.

Action Taken: A = Approved, AAN = Approved as Noted, RR = Revise and Resubmit, REJ = Rejected

1.10 SPECIAL TOOLS AND SPARE PARTS. The Contractor shall deliver all special tools and spare parts as required by this contract to the Engineer or as the Engineer directs.

1.11 IDENTIFICATION. Each unit of equipment shall be identified with an equipment item number. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name, size, model or any other information as the manufacturer may consider necessary, or as specified for complete identification. All tag numbers shall be assigned by DWSD.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 SUBMITTALS PROCEDURES. All documentation submitted by the Contractor to the Engineer shall be accomplished by a letter of transmittal. The submittal shall be submitted in a sequence that allows the Engineer to have all of the information necessary for checking and approving a particular document at the time of submittal. Each document shall be identified by a document number, DWSD Z-file number, contract number, contract name, location, Spectext section and subsection numbers and submittal date. Where a manual or drawing is revised to reflect a change for any other reason, each such revision shall be shown by a revision number, date and subject placed in a revision block. Indication of official approval by the Contractor's Project Manager shall also be included. To permit rapid location of the revision, additional notation shall be made in the manual opposite the line or area where the change was made, and identified by the corresponding revision number.

3.2 SUBMITTALS APPROVAL. Submittals are reviewed to verify conformance with the contractual requirements and check the accuracy of documentation to prevent costly mistakes and delays to construction. Approval of Contractor's documents by Engineer shall not relieve the Contractor of the responsibility to meet all of the requirements stipulated in the Contract Documents. The Contractor shall have no claim for additional costs or extension of time on account of delays due to revisions of the documents which are necessary for ensuring compliance with the contract.

Approval of documentation shall be the functional level. Any detailed design done prior to approval at the functional level shall be at the Contractor's risk.

Engineer will return documents to Contractor stamped "approved", "approved as noted", "revise and resubmit; or "rejected".

> Approved. The document may proceed with the work covered by the drawings or document.
>
> Approved As Noted. The Contractor may proceed with work after making change marked on returned drawing or documents.
>
> Revise and Resubmit. The Contractor may not proceed with work until drawing or document is resubmitted to the Engineer and returned to the Contractor with approved stamp. Any drawing marked "revise and resubmit" must be resubmitted or letter written explaining why document was not resubmitted.
>
> Rejected. The Contractor must not proceed with any construction relating to any "rejected" document. Any drawing marked "rejected" must have new document resubmitted or letter written explaining why document was not resubmitted.
>
> Returned Unreviewed. When the submittal is incomplete or is not applicable or necessary to the project, the submittal may be returned unreviewed.
>
> Information**.** The documents have been accepted for the record and have not been reviewed as defined above.
>
> Record Print**.** When documents are submitted after construction has been completed to comply with section Contract Closeout.

Only the Engineer shall utilize the color "red” in marking Shop Drawings and Submittal Documents.

The Engineer will review a submittal or resubmittal a maximum of 3 times, after which the cost of review will be borne by the Contractor. The cost of engineering shall be equal to the Engineer's full cost.

No partial submittals will be reviewed. An incomplete submittal or resubmittal will be returned to the Contractor for resubmittal.

When the shop drawings or document have been completed to the satisfaction of the Engineer, the Contractor shall carry out the construction in accordance with such drawings and shall make no further changes except upon written instruction from the Engineer.

3.2.01 Testing of Samples. The Engineer may require laboratory tests on samples submitted or may approve materials on the basis of data submitted with the samples. The Engineer shall determine the testing methods and number of tests.

If tested samples indicate a material does not conform to the Contract requirements, the Contractor will be notified of the rejection and given the basic reasons for such rejection. The Engineer will not furnish copies of all the test data or results.

3.2.02 Approval of Tested Materials. The Engineer's approval will only be general and does not constitute a waiver of the City's right to full compliance with the Contract requirements.

Approved materials shall not be changed in brand, make, or formulation without obtaining a new approval from the Engineer.

The Engineer shall check actual materials delivered to the site as necessary to insure compliance with the Contract requirements. Materials previously given general approval may be rejected for cause.

The Engineer shall have authority to require removal and replacement with proper materials which have been incorporated into the work if the material fails field check tests.

3.3 SUBMITTALS TRACKING. A control procedure shall be established by the Contractor to track submittal approval and revision for all documents and drawings. The Schedule of Submittals should be the foundation for tracking submittals approvals and revisions. The Contractor shall maintain his procedure from Contract award through completion of the final project acceptance, and shall provide the Engineer with six copies of the initial Configuration Control Document updated monthly as appropriate, for document drawing submittals or approval procedures.

3.4 RECORD PRINTS. The Contractor shall submit to the Engineer 3 set of all record prints within 60 days after submitting the "Certificate of Substantial Completion". The record prints or project records shall include catalog cuts, drawings, calculations, test reports, manufacturer's data maintenance manuals, installation instructions and operating manual. All "record prints" shall be delivered to the Engineer in cabinets as specified in 2.01 and shall have the DWSD Z-file number marked on them.

End of Section

SECTION 01090

PREDICTIVE TESTING AND INSPECTION

PART 1 – GENERAL

1.1 SCOPE. This section covers predictive testing and inspection requirements for materials and equipment supplied under this Contract.

1.2 GENERAL. Predictive Testing and Inspection (PT&I) technologies are used as part of a Reliability Centered Maintenance (RCM) process to establish maintenance strategies that optimize facility and equipment operability and efficiency, while minimizing life-cycle costs. The data acquired from PT&I permits an assessment of system/equipment performance degradation from the as-designed and/or required condition. The objectives of PT&I are to determine equipment condition and to develop a trend with which to forecast the most effective time to schedule and perform maintenance. Establishment of baseline data (vibration, thermographic, etc.) required by the equipment specifications shall be compiled, properly documented and submitted with the equipment O&M Manuals by the Contractor.

1.3 SUBMITTALS.

1.3.01 Measurements and Measurement Data. The Contractor shall furnish to the Engineer the following information concerning the equipment used to make the specified measurements:

Test Equipment – list of all test equipment used, including manufacturer, model, number, serial number, calibration date, certificate of calibration and special personnel qualifications required.

Equivalency – If the Contractor uses an equivalent test or procedure to meet the requirements of the Contract Documents the Contractor shall provide to the Engineer proof of equivalency.

1.3.02 Bearing Information. Drawings – The Contractor shall provide to the Engineer section drawings that show the component arrangement for all rotating equipment supplied under the contract. The sectional drawings shall accurately depict the bearing support structural arrangement, be drawn to scale and show the dimensions to the centerline of all rotating shafts.

Bearing Data – The Contractor shall provide to the Engineer the bearing manufacturer and part number for all bearings used in all rotating equipment supplied under this contract. The information shall be included on the sectional drawings for each bearing location.

Operating Data – The required equipment data the Contractor shall provide the Engineer under this contract shall include the operating speed for constant speed units and the normal operating speed range for variable speed equipment.

1.3.03 Gearbox Information. The Contractor shall provide to the Engineer the type and number of teeth on each gear used in the gearbox and the input and output speeds and gear ratios. This information shall be included on the sectional drawings which must be to scale and be specific to gear location.

1.3.04 Pumps. The Contractor shall provide to the Engineer the following information on all pumps supplied under the contract:

Number of pump stages

Number of pump vanes per stage

Number of gear teeth for each pump gear

Type of impeller or gears

Rotating speed

Balance specifications as per ISO G1.0 or API specification

Number of diffuser vanes

Pump nameplate data

Motor nameplate data

1.3.05 Centrifugal Compressors. The Contractor shall provide to the Engineer the following information on all centrifugal compressors supplied under the contract:

Number of compressor sections

Number of blades per section

Number of diffusers

Number of vanes per diffuser

Number of gears and teeth per gear

Number of gear teeth per driven shaft

Rotating speed of each rotor

Compressor nameplate data

Motor nameplate data

1.3.06 Fans or Blowers. The Contractor shall provide to the Engineer the following information on all fans supplied under the contract:

Type of fan or blower

Number of rotating fan blades/vanes

Number of stationary fan blades/vanes

Rotating speed(s)

Fan/blower nameplate data

Motor nameplate data

The Contractor shall provide to the Engineer the following additional information if the fans/air handlers are belt driven:

Number of belts

Belt lengths

Diameter of the drive sheave at the drive pitch line

Diameter of the driven sheave at the drive pitch line

For all fans supplied under the contract, the Contractor shall ensure sufficient access to the fan is present to allow for cleaning and in-place balancing of the fan.

1.3.07 Mixers/Flocculators. The Contractor shall provide to the Engineer the following information on all mixers/flocculators supplied under the contract:

Number of impellers

Type of impeller

Rotating speed

Mixer/flocculator nameplate data

Motor nameplate data

1.3.08 Clarifier Drives. The Contractor shall provide to the Engineer the following information on all clarifier drives supplied under the contract:

Rotating speed

Gear box data as described above

Drive nameplate data

Motor nameplate data

1.3.09 Mechanical Bar Screens. The Contractor shall provide to the Engineer the following information on all mechanical bar screens supplied under the contract:

Mechanism speed

Type of drive

Gear box data as described above

Bar screen nameplate data

Motor nameplate data

1.3.10 Chain and Flight Collectors. The Contractor shall provide to the Engineer the following information on all chain and flight collectors supplied under the contract:

Mechanism speed

Type of drive

Gear box data as described above

Chain and flight collector nameplate data

Motor nameplate data

1.3.11 Conveyors. The Contractor shall provide to the Engineer the following information on all conveyors supplied under the contract:

Belt speed

Conveyor nameplate data

Motor nameplate data

1.3.12 Belt Filter Presses. The Contractor shall provide to the Engineer the following information on all belt filter presses supplied under the contract:

Belt speed

Number of rollers

Belt filter press nameplate data

Motor nameplate data

13.13 Centrifuges. The Contractor shall provide to the Engineer the following information on all centrifuges supplied under the contract:

Rotating speed

Centrifuge nameplate data
Motor nameplate data

1.3.14 Lime Mixing Screw. The Contractor shall provide to the Engineer the following information on all lime mixing screws supplied under the contract:

Rotating speed

Lime mixing screw nameplate data

Motor nameplate data

1.3.15 Motorized Valves and Gates. The Contractor shall provide to the Engineer the following information on all motorized valves and gates supplied under the contract:

Rotating speed

Valve and gate nameplate data

Motor nameplate data

1.3.16 Lubricants. The Contractor shall provide to the Engineer the following information on all lubricants supplied in bulk or contained within equipment supplied under this contract:

Liquid Lubricants

a. Viscosity grade in ISO units as per ASTM tests

b. AGMA and/or SAE classification as applicable

c. Viscosity in Saybolt Universal Seconds (SUS) or centipoises at the standard temperature and at designed normal operating temperature

Grease Lubricants

a. National Lubrication and Grease Institute (NGLI) Number

b. Type of thickener

Hydraulic Fluids

a. Type of hydraulic fluid

b. ASTM test requirement

c. ISO number, if appropriate

d. Viscosity

e. Flash Point
f. Oxidation resistance

g. Pour point

h. Foaming

i. Cleanliness (ISO standard)

j. Four ball wear test

Insulating Fluids (Oil-filled transformers)

a. Type of oil used

b. Dielectric

c. Acidity

d. Specific gravity

e. Power factor

f. Dissolved gas

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.1 Vibration Measurements. The vendor shall provide to DWSD the following information for all equipment where vibration testing is specified in the contract:

Narrowband spectral vibration data for all machines as follows:

a. For machines operating at or below 1,800 rpm, the frequency spectrum provided shall be in the range of 0 to 5000 Hz.

b. For machines operating greater than 1,800 rpm, the frequency spectrum shall be in the range of 0 to 10,000 Hz.

c. Two narrowband spectra for each point shall be obtained in the following manner:

- For all machines regardless of operating speed, a 5 to 500 Hz spectrum with 1600 lines of resolution shall be used to analyze balance, alignment and electrical line frequency faults.

Vibration data shall be reported in velocity (inches/second)

Vibration data shall be collected at normal operating load, temperature and speed.
If rolling element bearings are utilized in either the driver or driven component of a unit of equipment (e.g., a pump/motor combination), no discrete bearing frequencies should be detectable.

For belt-driven equipment, belt rotational frequency and harmonics should be undetectable.

If no specific criteria are available, the ISO 3945 acceptance Class A guidelines should be used as the acceptance specification.

3.2 Vibration Transducer Mounting. At the designated measurement positions, suitable surfaces shall be provided such that the mounted transducer will attach securely. Mounting locations shall be positioned on structural members. Installation of sound discs on bolted cover plates or other non-rigid members are not acceptable.

Magnetic Mount – For a magnetic base mounted transducer, the location on the machine's surface at which vibration measurements are to be taken shall be machined (faced) or cast 1.1 x diameter of the mounting surface of the magnet to be set on the surface, flat within 25 um (1 mil), and a minimum surface finish (surface texture of 25 um (1 mil). During measurements, the mounting location shall be clean and free of debris and paint, so that the magnet base can be attached firmly without rocking.

Stud Mounted – For a stud mounted transducer, the machine's surface at which vibration measurements are to be taken shall be machined (faced) with a minimum surface diameter of 1.1 x diameter of the mounting surface of the transducer to be mounted on the surface, flat within 25 um (1 mil), and a minimum surface finish (surface texture) of 25 um (1 mil). The tapped hole shall be M6 x 1H (1/4 x 28), unless otherwise specified, with a minimum depth of at least two threads deeper than the stud. The hole shall be perpendicular to within 1^{o} to the mounting surface.

Adhesive Mounting – Adhesives will lower the accelerometer mounted resonance frequency (usually supplied for stud mounting). If an adhesive is used to attach either the transducer or a magnetic mounting pad, the upper frequency limit of the transducer shall be reduced by 20% of the manufacturer's stated resonance for hard adhesives and by 50% of the manufacturer's stated resonance for soft adhesives. Transducer manufacturer's specifications should be consulted. The machine's surface at which vibration measurements are to be taken shall be machined (faced) with a minimum surface diameter of 1.1 x diameter of the mounting surface of the transducer to be mounted on the surface, flat within 25 um (1 mil). The surface shall be abraded to approximately 25 um (1 mil) to increase adhesion. The adhesive bond layer thickness should be less than 1 mm.

3.3 Vibration Measurement Locations. Centrifugal Pumps, Vertically Mounted – Magnets shall be mounted in the radial direction as close to the bearings as possible. Accelerometers shall be mounted to solid structures and not on drip shields or other flexible structures. Mounting locations shall be in line with each other, perpendicular to the pump discharge and located at the free end, at the coupled end of the motor and pump, and in the axial direction on the pump and motor, if possible.

Centrifugal Pumps, Horizontally Mounted – Magnets shall be mounted in the horizontal and vertical planes radial to the shaft at the free and coupled ends of the motor and pump, as close to the bearing as possible. Accelerometers shall be mounted to solid structures and not on drip shields or other flexible structures. Mounting locations shall be in line with each other, perpendicular to the pump discharge and located at the free and coupled end of the motor and pump, and in the axial direction on the motor and pump, if possible.

Positive Displacement Pumps -Magnets shall be mounted in the horizontal and vertical planes radial to the shaft at the free and coupled ends of the motor and pump, as close to the bearing as possible. Accelerometers shall be mounted to solid structures and not on drip shields or other flexible structures. Mounting locations shall be in line with each other, perpendicular to the pump discharge and located at the free and coupled end of the motor and pump, and in the axial direction on the motor and pump. An exception may be granted if the pump is sump mounted.

Generators – Magnets shall be mounted in the horizontal and vertical planes on the free ends of the motor and generator bearing assemblies. Pedestal bearings between the motor and generator should be monitored in the vertical direction radial to the shaft. Thrust bearings shall be monitored in the axial direction.

Gear Boxes – Magnets shall be mounted radial to the input and output shafts in the horizontal and vertical directions. Additional discs shall be installed in the axial direction as close to the input and output shafts as possible.

Centrifugal Compressors - Magnets shall be mounted radial to the input and output shafts in the horizontal and vertical directions. Additional discs shall be installed in the axial direction as close to the input and output shafts as possible. (Reciprocating air compressors shall only be monitored for balance and alignment problems).

Blowers and Fans – Motors on blowers and fans shall have magnets mounted in the radial and axial directions as previously described. Fan bearings shall be monitored radially in the vertical direction.

Chillers

a. Centrifugal – Magnets shall be mounted in the horizontal and vertical planes radial to the shaft at the free and coupled ends of the motor and compressor as close to the bearings as possible. Accelerometers shall be mounted to solid structures and not on drip shields or other flexible structures. Mounting locations shall be in line with each other, perpendicular to the compressor discharge and located at the free end, at the coupled end of the motor and compressor, and in the axial direction on the compressor and motor.

b. Reciprocating - Magnets shall be mounted radial to the input and output shafts in the horizontal and vertical directions. Additional discs shall be installed in the axial direction as close to the input and output shafts as possible.

3.4 <u>Convention for Identifying Vibration Measurements</u>. Vibration measurement locations documented for certification and acceptance on the equipment layout drawing and on any vibration data submitted shall follow the following conventions:

a. Component Part (shaft, gearbox, roll, etc.): four (4) alphanumeric characters:

- Four user defined alphanumeric characters provide a flexible means to identify specific component parts of a machine for convenience and purposes of automated diagnosis. Examples include individual shafts rotating at different speeds within a complete machine (i.e. SFTC to indicate shaft C), an auxiliary gearbox with multiple shaft speeds that differ from the shaft speeds of the main machine (i.e. AGB6, auxiliary gearbox, position number 6).

b. Location (bearing number designation): three (3) numeric characters:

- A numeric sequence identifying the specific bearing on which a vibration measurement is recorded using three numeric numbers. For purposes of this specification, the numeric sequence starts at the outboard bearing position of the driver machine (motor), which is designated as location 001.

c. Sensor (transducer) Type Code: two (2) letters:

- Sensor type is designated by a two-letter abbreviation according to the following:

AA	Single Axis Accelerometer
AC	Single Axis Accelerometer with internal integration
AT	Triaxial Accelerometer
CT	Current Transformer
DP	Displacement Probe
DR	Displacement Probe used as a Phase Reference
LT	LVDT (Linear Voltage Differential Transformer)
MP	Magnetic Pickup (shaft speed/phase reference)
MI	Microphone
OP	Optical Pickup (shaft speed/phase reference)
PD	Dynamic Pressure
PS	Static Pressure
SG	Strain Gage
TC	Temperature – Thermocouple
TR	Temperature – RDT
TT	Torque Transducer
TO	Torsional Transducer
VP	Velocity Pickup
VT	Voltage
OT	Other

c. Angular Orientation: three digits (000 to 360 degrees):

- Foot-Mounted Equipment – The angular position of a vibration sensor is measured from a zero reference located at 3 o'clock when viewed at position 001, looking into the equipment. The 12 o'clock position on the equipment surface is opposite the equipment mounting plate. The angle increases counterclockwise (regardless of the direction of shaft rotation) in the plane of the shaft rotation from 0o to 360o.

- Flange-Mounted Equipment - The angular position of a vibration sensor is measured from a zero reference located at the point of energy input on the motor, when viewed from position 001 looking into the equipment (in the direction from driver to driven). The angle increases counterclockwise (regardless of the direction of shaft rotation) in the plane of the shaft rotation from 0o to 360o.

d. Sensor Axis Direction (Orientation): one (1) letter:

- A single letter defines the direction of the sensor sensitive axis. This portion of the identification provides unique descriptive information when the sensor sensitive axis does not coincide with the radial defined in the previous section. It is redundant when the sensitive axis coincides with the defined radial.

R – Radial	sensor sensitive axis perpendicular to and passes through the shaft axis
A – Axial	sensor sensitive axis parallel to the shaft axis

T – Tangential sensor sensitive axis perpendicular to a radial in the plane of the shaft rotation
H – Horizontal sensor sensitive axis oriented at 000 or 180 degrees only
V – Vertical sensor sensitive axis oriented at 090 or 270 degrees only.

e. Direction of Motion: one (1) letter:

- The final character in the measurement identification code is either an N (normal) or R (reverse) to identify sensors mounted in opposition where machine motion in one direction results in positive motion in one sensor (N – normal) and negative motion (R – reverse) in the other. Axial sensors mounted in opposite directions at opposing ends of equipment are the primary example. Axial machine motion toward the reference end is normally designated as positive. The axial sensor closest to the reference end of the machine, position 001, will be designated normal (N) when mounted such that the positive motion toward the sensor produces a positive signal output. Likewise, motion toward the reference end will produce a negative signal from the axial sensor at the opposite end, which is then designated R (reverse). The angular orientation defines the direction of motion for radially mounted sensors. Therefore, default of N (normal) should be utilized for sensors mounted radially.

An example measurement identification is: SFTA003AC090RN (shaft A, bearing number 3, single axis accelerometer positioned 90 degrees counterclockwise from zero, mounted radially, normal motion).

3.5 Thermography. The Contractor shall perform thermographic surveys, when specified, as follows:

Electrical – Thermographic surveys shall be performed on all electrical distribution equipment, motor control centers and transformers during the startup phase of the installation, unless specifically waived by the Engineer. Any defects noted by an observable difference in temperature of surveyed components or unexplained temperature rise above ambient shall be corrected by the Contractor at no additional expense to the Owner. The Contractor shall resurvey repaired areas to assure proper corrective action has been taken.

Piping Insulation - Thermographic surveys shall be performed on all insulated piping during the startup phase of the installation, unless specifically waived by the Engineer. Any voids in the piping insulation shall be corrected by the Contractor at no additional expense to the Owner. The Contractor shall resurvey repaired areas to assure proper corrective action has been taken.

Building Envelope – A thermographic survey shall be performed of the building envelope to check for voids in insulation and/or the presence of wetted insulation. In addition, the presence of air gaps in building joints such as seams, door frames, window frames, etc. shall be checked via a thermographic survey using the appropriate procedure specified in the following:

a. ASTM C1060-90 – Thermograhic Inspection of Insulation in Envelope Cavities in Wood Frame Buildings

b. ASTM C1153-90 – Standard Practice for the Location of Wet Insulation in Roofing Systems Using Infrared Imaging

c. ISO 6781 – Thermal Insulation – Qualitative Detection of Thermal Irregularities in Building Envelopes – Infrared Method

d. ASTM E1186-87 –Standard Practices for Air Leakage Site Detection in Buildings

The Contractor shall clearly identify by photographs, scale drawings, and/or by description all voids or gaps noted during the thermographic scan. For areas where the moisture content of the insulation or building envelope is questionable, the Contractor shall use either destructive or non-destructive testing techniques that confirm the amount of moisture. Specific testing procedures shall be proposed by the Contractor and approved by the Engineer.

Boilers, Furnaces, and Ovens – A thermographic survey shall be performed during the startup phase of installation of all boilers, furnaces and ovens as a means of determining voids in insulation or refractory materials. Any voids detected during the survey shall be corrected by the Contractor at no expense to the Owner. The Contractor shall perform a thermographic survey of all repaired areas prior to final acceptance by the Owner.

Motors and Bearings – Thermographic scans should be performed on large units to identify abnormal hot spots on the body that may indicate flaws in the stator winding.

Power transformers - Thermographic scans should be performed to identify abnormal heating at connections, localized heating, temperature variations in cooling fins or tubes and temperature differences between units.

3.6 Airborne Ultrasonics. The Contractor shall perform an airborne ultrasonic survey during the startup phase of the installation where airborne ultrasonic testing is specified in the contract. The Contractor shall survey electrical equipment for indication of arcing or electrical discharge, including corona.

Any defects or exceptions noted by the use of airborne ultrasonics shall be corrected by the Contractor at no additional expense to the Owner. The Contractor shall resurvey repaired areas to assure proper corrective action has been taken.

3.7 Pulse Echo Ultrasonics. Material thickness measurements shall be performed on a representative sample of all material where a thickness is specified in the contract. Thickness measurements shall be performed at the fabricator’s place of business prior to shipment of any material to the project site. Material which does not meet the specified requirements of the contract shall not be shipped without the prior approval of the Engineer.

3.8 Motor Circuit Analysis (Complex Phase Impedance). Upon motor installation, the Contractor shall take and provide to the Engineer the following acceptance/baseline readings and measurements, first for the motor alone, and then for the motor and circuit together:

a. Conductor path resistance

b. Inductive imbalance

c. Capacitance to ground

3.9 Motor Current Spectrum Analysis. With the motor installed and operational, the Contractor shall conduct an acceptance/baseline spectral analysis on the loaded motor at 75% or greater load when specified by the Engineer.

3.10 Insulation Resistance. Upon installation, the Contractor shall take and provide to the Engineer the following acceptance/baseline readings and measurements, first for the motor alone, and then for the motor and circuit together:

a. Polarization index (Motors of 500 HP or more only)

b. Dielectric absorption ration (for all motors)

c. Leakage current at test voltage

3.11 Surge Testing. The Contractor shall perform surge testing of the motor(s) prior to their installation and Owner acceptance. The Contractor shall provide to the Engineer documentation of test results, including test voltage and waveforms.

3.12 Startup Tests. With the motor installed and operational, the Contractor shall collect and provide to the Engineer the following baseline data:
a. Coast-down time
b. Peak starting current

3.13 Maintainability and Ease of Monitoring. The Contractor shall provide for facility and equipment maintainability and ease of monitoring.

3.14 Leveling of Equipment Upon Installation. The Contractor shall level all installed rotating electrical and mechanical machinery. After installation, the equipment shall not exceed a maximum slope of the base and the frame of 0.001 inch per foot. The Contractor shall report to the Engineer the type and accuracy of the instrument used for measuring the level; e.g., a 12-inch machinist's level graduated to 0.0002 inch per foot.

3.15 PT&I Technology Schedule.

a. Equipment Type PT&I Technology

b. Pumps Lubricant analysis
Vibration

c. Compressors Vibration
Lubricant analysis

d. Blowers/Fans Vibration
Lubricant analysis

e. Gearboxes Vibration
Lubricant analysis

f. Boilers, Furnaces Infrared thermography

g. Insulated Piping Infrared thermography
Piping/pressure vessels (thickness) Pulse echo ultrasound

h. Chillers/Refrigeration Infrared thermography
Lubricant analysis
Vibration

i. Electrical switchgear/ Circuit breakers Airborne ultrasound
Infrared thermography
Insulation resistance

j. Motor and motor circuits Insulation resistance
Motor circuit analysis
Motor current spectrum analysis
Startup tests

k. Building envelope Infrared thermography

l. Heat exchangers/condensers Infrared thermography
Airborne ultrasound

m. Electric motors Vibration
Surge testing
Infrared thermography

n. Electrical generators Vibration
Motor circuit analysis
Insulation resistance

o. Transformers Infrared thermography
Oil analysis

	Insulation resistance	
p.	Rotating equipment electrical/ Mechanical	Equipment leveling

End of Section

SECTION 01100

TRAFFIC CONTROL

PART 1 - GENERAL

1.1 SCOPE The Contractor shall develop a Construction Traffic Plan to minimize interference from construction vehicles and equipment on pedestrians and traffic in compliance with local authority having jurisdiction.

1.2 SUBMITTALS. Contractor shall prepare and submit a Construction Traffic Plan detailing the location of construction entrances onto the project site, construction delivery routes, general traffic patterns, and temporary parking areas. The construction Traffic Plan shall detail the types of traffic barricades, controls, signage, and temporary pavements that will be used to maintain safety and minimize interference with non-construction vehicles.

The Construction Traffic Plan shall be submitted and approved by the Engineer before mobilization onto construction site begins.

PART 2 - PRODUCTS

2.1 BARRICADES, ARROW BOARDS, TEMPORARY PAVEMENT MARKINGS, AND TEMPORARY SIGHN. Barricades, Arrow Boards, Temporary Pavement Markings, Temporary Signs, and other traffic control devices shall be in accordance with the current edition of the MDOT Standard Specifications for Construction, and the current edition of the Michigan Manual of Uniform Traffic Control Devices.

PART 3 - EXECUTION

3.1 SITE ACCESS AND PARKING. Construct all weather access road(s) and Parking area(s) within the site to serve the construction area. Access road shall be of a width and load-bearing capacity to provide unimpeded traffic for construction purposes. Access drives and parking areas shall be hard surfaced unless otherwise approved by the Engineer. Provide and maintain access to fire hydrants and control valves at all times.

No highway, street or road shall be blocked to traffic without a Right-of-Way permit issued by the authority having jurisdiction to do so.

Bridges over pipe trenches and/or temporary roadways shall be built and maintained as required by the authority having jurisdiction over the highway, street or road.

Drainage through existing sewers and drains shall be maintained at all times during construction except as expressly provided for in these specifications

Parking control shall be managed according to an approved Construction Traffic Plan. Monitor parking to prevent interference with access by emergency vehicles and to make the best use of limited parking areas. Access to fire hydrants, control structures, existing facilities, and water and gas valves shall not be obstructed. Do not allow parking in non-designated areas by construction personnel.

The Contractor shall maintain driveways a minimum of 15 feet wide between and around combustible materials in storage and mobilization areas.

The Contractor shall maintain traffic areas as free as possible of excavated materials, construction equipment, products, snow, ice, and debris.

The Contractor shall not utilize existing parking facilities for construction personnel or for Contractor's vehicles or equipment, unless written permission from owner of parking facility is obtained.

3.2 TRUCKING ROUTE AND PUBLIC ROAD MAINTENANCE. Prior to the start of construction, the Contractor shall submit for review a schedule and list indicating the streets and roads within the municipality that his equipment will use off the Project site.

The Contractor shall comply with all safety requirements, weight restrictions and speed limits.

All gravel and dirt roads or streets used shall be maintained by grading, placing dust palliatives and maintenance gravel in sufficient quantities to eliminate dust and maintain traffic.

Paved streets shall be maintained in a reasonable state of cleanliness and the Contractor shall remove accumulations of debris, dirt or mud caused by his operations. Removal shall be done in such a manner as to prevent the release of dust. This shall be done at least every day at the close of each day's operation or additionally when requested by the Engineer.

Any roads or streets damaged by the Contractor’s operations shall be repaired or removed and replaced to satisfactions of the agency having jurisdiction at no additional cost to the Project.

The Contractor shall not store any equipment, supplies, construction material or excess excavated material on any roads or streets unless otherwise approved by the Engineer.

3.3 EMERGENCY ACCESS. The Contractor shall at all times provide emergency access to property in the vicinity of the construction for police vehicles, fire equipment, ambulances or other emergency vehicles to protect life, health and property. Any areas damaged by emergency vehicles shall be restored by the Contractor at no additional cost to the Owner.

3.4 PRIVATE OR PUBLIC ROADS, SIDEWALKS, AND PARKING AREAS. Where public roads, driveways, parking areas and sidewalks are encountered throughout the project, the Contractor shall maintain those portions affected by the construction operations in a passable condition until such time as final restoration of these improvements can be made as specified. If, in the opinion of the Engineer, the public safety is in danger or the necessity exists for maintaining traffic, the Engineer may direct that backfilling be completed immediately. In the event that the necessary backfill material and equipment are not available when direction is given for immediate backfill, the trench shall be backfilled with native material to provide for the necessary maintenance of traffic and safety; however, the native material shall be removed within 48 hours and the trench properly backfilled as specified.

Where private roads are encountered throughout the project, the Contractor shall maintain those portions affected by its construction operations in a passable condition. These roads shall be maintained by the use of 21A road maintenance gravel, stone or slag. In the event the original sub-base has been destroyed, the Contractor shall furnish and install 1-inch to 2-inch (25 to 50 mm) aggregate to stabilize the existing sub-base. Upon completion of the construction activities, the Contractor shall shape and re-grade these roads leaving them in a condition as good as or better than original, and adequate for normal travel.

3.5 ROAD CLOSING. No street, road or section thereof shall be closed to through traffic unless otherwise provided for on the Plans, Specifications, or authorized by the agency with jurisdiction over the roads. Prior to closing a street, road, or section thereof, the Contractor shall provide the Engineer with a copy of a detour plan approved by the agency having jurisdiction over the roads.

In the event roads or streets are to be closed, the Contractor shall notify the local fire department, police department, local road authority, ambulance and emergency services, Department of Public Works, public transit authority and public school system daily as to what streets will be partly blocked or closed, the length of time the streets will be blocked or closed and when the streets will be reopened to traffic. The Contractor shall designate one responsible employee to carry out the requirements of this condition.

During the time that the road is closed, the Contractor shall make provision for trash, leaf, and rubbish pickup.

3.6 MAINTAINING TRAFFIC. The Contractor shall provide access for local traffic to property along the Project by means of temporary roads, drives, culverts or other means approved by the Engineer. The Contractor shall grade, add surfacing materials, and dust palliatives to such temporary roads and drives as necessary for the proper maintenance of traffic.

The Contractor shall maintain traffic and parking areas in a sound condition, free of excavated material, construction equipment, construction materials, mud, snow and ice at all times. Repair breaks, potholes, low areas, standing water, and other deficiencies promptly to maintain paving and drainage in original, or specified, conditions.

Where the shoulder is used to maintain traffic, the shoulder shall be graded, surfaced, treated for dust, constructed, or reconstructed, as specified herein or as shown on the Plans. If the construction work is suspended due to weather conditions, winter shut down or for any other reason, sufficient labor, materials and equipment shall be ready for immediate use at all times for the proper maintenance of traffic. Surfacing materials and dust palliatives shall be applied at such times and locations and in such amounts as necessary to safely maintain traffic and as determined by the Engineer.

Where shoulders are low, high, soft or rough, adequate provisions shall be taken to inform and protect the traveling public by means such as construction warning signs, barricades, lighted devices, etc. Such shoulder hazards shall be eliminated as soon as practicable.

The Contractor shall furnish, erect and maintain all signs, barricades, lights, and traffic regulators, in accordance with the requirements of the current "Michigan Manual of Uniform Traffic Control Devices". Furnish all flagmen and watchmen as are necessary to maintain and safeguard traffic along the entire Project. Failure to comply with these requirements may be cause for the Owner to issue a stop Work order, which shall remain in effect until all necessary devices are in place and operational. The issuance of a stop Work order shall not be reason for granting additional compensation or an extension to the Contract Time. Furnishing, installing, and maintaining traffic control devices shall be incidental to the Project unless otherwise provided for in the Proposal.

3.7 WORK WITHIN RAILROAD COMPANY RIGHT OF WAY. The Contractor shall be responsible for complying with the requirements of the Railroad Company for all Work of the Project and/or temporary crossings for trucking routes. Unless otherwise provided by an item of these Specifications, the Contractor shall bear all costs and expenses incidental thereto, including, but not limited to, protection, flagmen, construction engineering inspection by the railroad, and incidental work such as drainage facilities and removal, alteration and replacement of railroad fences.

3.8 EXISTING TRAFFIC SIGNS. No stop sign, traffic control or warning device or sign shall be taken down until the agency having jurisdiction over the roads has been notified and arrangements for the immediate reinstallation has been made. The Contractor shall provide temporary signs, traffic control devices, warning devices, or watchmen continuously from the time the item is removed until it is reinstalled. All signs removed shall be replaced with signs meeting requirements of the agency having jurisdiction over the roads.

3.9 TRAFFIC REGULATION FOR SAFETY. If the Contractor fails to promptly provide or neglects to maintain the traffic and parking areas, or is dilatory in carrying out specific instructions of the Engineer, DWSD may, with or without notice to the Contractor, take such remedial measures deemed necessary and charge the Contractor with any costs incurred. Any such action shall in no way serve to release the Contractor from its general or particular liability for safety.

3.10 REMOVAL. Remove all signs, cones, drums, and barricades when traffic regulation is no longer required. Repair existing roads damaged during construction and remove any temporary pavements prior to final completion. Restore facilities damaged by construction usage to original condition as determined by the Engineer.

End of Section

SECTION 01110

CONSTRUCTION FACILITIES AND IDENTIFICATION

PART 1 – GENERAL

1.1 SCOPE. This section defines the temporary utilities, project control devices, fencing, construction facilities, progress cleaning and signage to be used during the work, and their subsequent removal.

1.2 TEMPORARY UTILITIES.

1.2.01 Temporary Light and Power. The Contractor shall provide all temporary electric service and lighting required during the entire construction period and pay all costs for installing, maintaining and removing temporary service. Include all necessary temporary wiring, panel boards, outlets, switches, lamps, fuses, controls and accessories in accordance with Master Specification Division 16000, Electrical.

Provide a sufficient number of electric outlets located so that 50 foot long extension cords will reach all work requiring light or power. All temporary 120 volt, 15 and 20 amp receptacle outlets shall be GFI protected. All temporary service equipment shall be removed by the electrical subcontractor when so instructed by the general contractor. The general contractor shall be responsible for payment of the electric bill.

The contractor shall provide lighting in the field office of at least 100 foot candles throughout.

1.2.02 Temporary Heating. Each subcontractor shall provide temporary heat as necessary to their work and materials from damaging dampness and freezing. Temperatures shall be maintained as per ASTM requirements. Precautions shall be taken against possible spread of fire and the possible damaging effects to building and equipment from smoke and soot.

1.2.03 Heating and Cooling of Field Office. The contractor shall provide heating and cooling of the field offices sufficient to maintain 68-78 degrees F (20-26 degrees C) and 30% to 50% humidity throughout the year.

1.2.04 Telephone Service. Contractor shall provide, maintain and pay for telephone service to field office and Engineer’s field office starting at time of project mobilization.

Subcontractors shall provide their own telephone service, if needed, on construction site.

1.2.05 Copier and Facsimile Service. Contractor shall provide, maintain and pay for a copier and facsimile service and a dedicated telephone line to field office at time of project mobilization.

Subcontractors shall provide their own copier and facsimile service, if needed, on construction site.

1.2.06 Temporary Water Service. The General Contractor shall pay for all water required during the entire construction period. The site utilities subcontractor shall pay tap fees and shall lay a temporary water line from the source, fit with a hose bib, and shall provide and maintain all valves, connections and hoses.

The General Contractor shall furnish drinking water from an approved source for all persons on the work site. Each subcontractor shall provide containers for their personnel.

If the use period for the temporary water installation includes freezing weather, the site utilities subcontractor shall provide insulation for all exposed temporary service piping to prevent freezing.

1.2.07 Temporary Toilets. The General Contractor shall provide and maintain in a sanitary manner, temporary toilets as necessary for the use of the workmen.

1.3 CONSTRUCTION FACILITIES.

1.3.01 Field Offices. The Contractor shall provide clean, well maintained, temporary field office space and furnishings for the project engineer, superintendent and administration staff on the construction site. In addition, the field offices shall include a separate office for the owner and engineer to use when on-site and a conference room of sufficient size to conduct weekly progress meetings with subcontractors and a monthly progress meeting with the owner.

The Project Engineer, Superintendent, and Owner/Engineer offices shall be a minimum of 120 square feet (11 square meters). All other employees shall have 80 square feet (7.4 square meters) of work space minimum. The conference room shall be sized at 15 square feet (1.4 square feet) per person based on the largest recurring meeting that will be held.

Field offices shall be portable or mobile buildings or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors. They shall be structurally sound, secure, weather tight enclosures and shall be maintained during progress of work. Remove at completion of work.

Permanent facilities shall not be used for field offices or for storage.

1.3.02 Furnishing. Each workspace shall have a 30”x60” desk, two desk chairs, telephone, file drawer, one fax machine, at least one duplex outlet, and lighting that is functional and in good condition.

The project engineer and superintendent offices shall each have a 36”x42” drafting table, one plan rack (minimum capacity eight plan sets), one first aid kit, and one 10A: 80 – B:C fire extinguisher.

The conference room shall include a conference table and chairs to seat all attendees at recurring meetings.

The contractor shall furnish and maintain bottled water and sanitary facilities for the field office. The contractor shall clean the office at least once per week. The contractor shall provide and pay for all utility service throughout the duration of the Project, including local telephone service and long distance telephone service.

A trailer having equal facilities and floor space may be used in place of the described field office if so desired.

The field office shall be furnished with a minimum of an aggregate surfaced driveway and parking area, for the exclusive use of the engineer, for at least (3) vehicles. Contractor shall maintain parking area including snow removal.

The cost for furnishing and installing the field office, for furnishing utilities and utility service, and for maintenance of the field office and facilities, unless otherwise specified in the proposal, will not be paid for separately but shall be included in the price bid for various items of work under the contract. The field office shall be removed by the contractor upon completion of the contract and shall become his property.

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1.3.03 Security of Field Office. The field offices shall be locked at night with grills over each window and bars across each door. In addition, a reliable security system shall be installed with detectors at each door and window and a motion detector in each room. The system will be connected by telephone and radio to command post and monitored during all non-working hours. Any alarm shall result in an immediate dispatch to site and investigation. Construction field offices are a highly visible target for theft and vandalism. The Contractor will take whatever measures are necessary to minimize exposure.

1.3.04 Storage Sheds. The Contractor shall provide temporary storage as necessary to house materials provided by the Contractor. The field offices will not be used for storage. The storage sheds will be heated and cooled as necessary to protect the materials stored therein.

1.3.05 Subcontractor Field Offices and Storage. Each subcontractor shall provide their own field offices and storage space as needed to perform their work. They shall not rely on the General Contractor for office space, telephones or storage space. Any utilities needed to support subcontractor office space and storage shall be at their expense.

Prime subcontractors shall furnish storage facilities large enough to hold all materials required on the site at any one time that might be subject to damage or vandalism. The facilities shall be constructed to prevent damage from the elements and so they can be adequately secured. Location on the site shall be as per the General Contractor's instructions. Each subcontractor shall be responsible for the security of his own materials and equipment.

1.3.06 Project Identification and Signage. Advertising signs of any kind shall not be erected or displayed on the site. At the start of the work, the Contractor shall furnish and erect one or more project signs as directed by the Engineer bearing the following information:

> Project number, title and name of Owner as shown on the Contract Document
>
> Names and titles of Authorities
>
> Names and titles of Engineer/Consultant
>
> Name of Contractor and major subcontractors

Job instruction signs, such as 'DANGER", "KEEP OFF", "NO CONTRACT PARKING", etc., shall be furnished, erected and maintained by the Contractor as may be required to conduct the work safely. Such signs shall be neat in appearance, shall be maintained in good condition and shall be promptly removed when they have served their purpose. Erect at appropriate locations to provide required information.

1.4 TEMPORARY CONTROLS.

1.4.01 Fencing. Provide 6 foot (1.8 m) high fence around construction site; equip with vehicular gates with locks. Post and rails shall be roll-formed, open scam, self-draining shapes or standard weight Schedule 40 pipe, all galvanized in accordance with ASTM-F1043 Type A. All fittings shall be pressed steel or malleable iron and shall be hot-dip galvanized conforming to ASTM-A153. The wires shall be minimum 10 gage (.35 cm) galvanized steel. Maximum spacing of line posts to be 10 feet (3.05 m) unless noted on drawing. Fence to follow ground line unless otherwise provided for in this specification. Fencing shall be per Master Specification Section 2820, Chain Link Fences and Gates.

1.4.02 Safe Premises. It shall be the responsibility of each subcontractor to maintain all areas adjacent to the construction site in a manner not to hinder or endanger normal traffic flow, or endanger or damage adjacent property. Streets and sidewalks adjacent to the site shall be kept clean and open for pedestrian and vehicular traffic.

Each subcontractor is to provide scaffolding necessary for all of his work. All scaffolding must be built in accordance with the requirements of Federal, state and local regulations.

Temporary stairs, ladders and ramps shall be provided by each subcontractor for his work in order to safely enable access to all parts of the work by the Engineer, the Owner, the HUD representative and any authorized inspection personnel. All such equipment shall meet all Federal, state and local safety requirements.

1.4.03 Pest/Rodent Control. General Contractor shall provide methods and means to prevent pests and rodents from damaging work or entering facility.

The Contractor shall be responsible to contract for the extermination of all insects, rodents and other pests, if necessary, prior to turning over the project for occupancy.

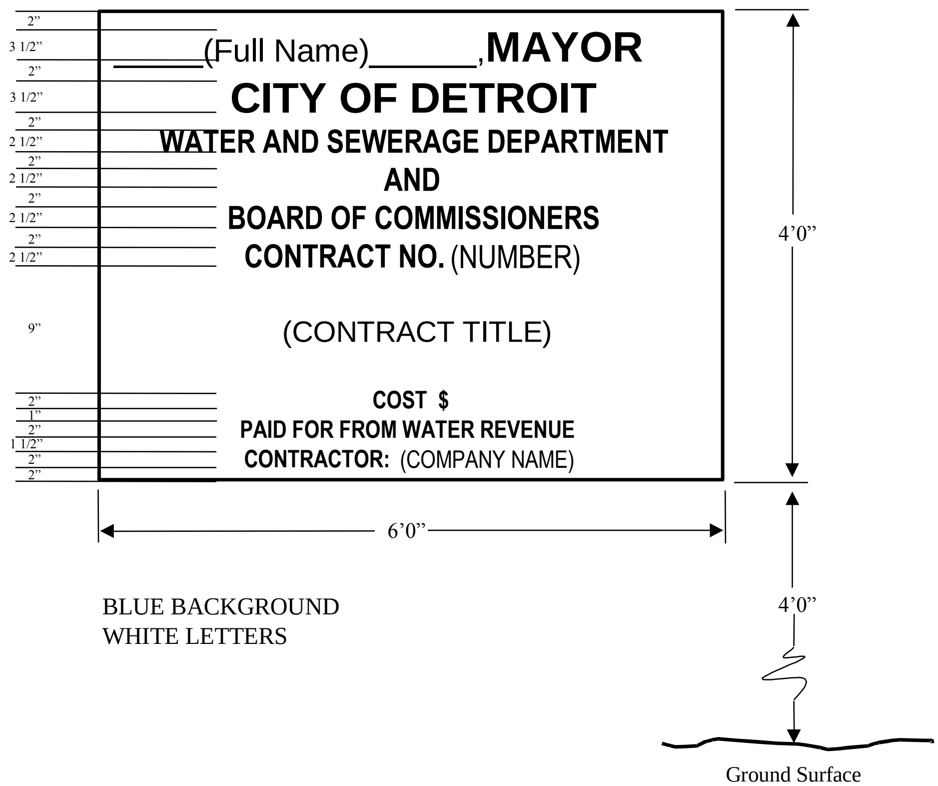
1.5 REMOVAL OF UTILITIES, FACILITIES AND CONTROLS. Remove temporary utilities, equipment, facilities, materials, prior to final inspection. Remove underground installations to a minimum depth of 2 feet (600 mm). Clean and repair damage caused by installation or use of temporary work. Restore and landscape area used during construction to specified condition.

1.6 QUALITY ASSURANCE. Sign painter shall have 5 years documented professional experience in type of work required.

Finishes and painting shall be adequate to resist weathering and fading for scheduled construction period.

PART 2 – PRODUCTS

2.1 PROJECT SIGN. Size of signs and lettering shall be as required by regulatory agencies or as appropriate to usage. See drawing of sign shown below.



Structure and framing may be new or used, wood or metal, in sound condition, structurally adequate to work and suitable for specified finish.

Sign surface shall be exterior plywood with medium density overlay, standard large sizes to minimize joints with sufficient thickness to span framing members, to provide even, smooth surface without waves or buckles.

The entire woodwork of the sign shall be given a priming coat of white exterior paint primer. The sign, including framework, shall be given two (2) coats of white exterior paint.

Project information signs shall be painted signs with painted lettering or standard products and shall be done by a skilled sign painter.

Wrought hardware shall be galvanized.

2.2 MATERIALS. Provide new materials. If acceptable to the Engineer, the Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

Lumber, plywood, and plastics shall comply with requirements in Master Specification Division 6, Wood and Plastics:

For job-built temporary offices, shops, and sheds within the construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.

For signs and directory boards, provide exterior-type, Grade B-B high-density concrete form overlay plywood of sizes and thickness indicated.

For safety barriers, sidewalk bridges, and similar uses, provide minimum 5/8-inch (16-mm) thick exterior plywood.

Paint shall comply with requirements of Master Specification Section 9900, Painting.

For job-built temporary offices, shops, sheds, fences, and other exposed lumber and plywood, provide exterior-grade acrylic-latex emulsion over exterior primer.

For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.

For interior walls of temporary offices, provide 2 coats interior latex-flat wall paint.

Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of 15 or less. For temporary enclosures, provide translucent, nylon-reinforced laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

2.3 Equipment. Provide new equipment. If acceptable to the Engineer, the Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.

Provide 3/4-inch (19-mm), heavy-duty, abrasion-resistant, flexible rubber water hoses 100 feet (30 m) long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

Provide temporary heating/cooling units that have been tested and labeled by UL, FM or another recognized trade association related to the type of fuel being consumed in accordance with Master Specification Division 15000, Mechanical.

Provide self-contained, single-occupant temporary toilet units of the chemical, aerated recalculation, or combustion type. Provide units properly vented and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

Provide hand-carried, portable, UL-rated, Class "A" fire extinguishers for temporary offices and similar spaces. In other location, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures.

Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

Provide a minimum of two (2) temporary pumps, suitable for the fluid pumped, complete with controls for each temporary bypass and process pumping required to complete the Work in accordance with Master Specification Division 11000, Equipment.

PART 3 – EXECUTION

3.1 INSTALLATION. Use a qualified personnel for installation of temporary facilities. Locate facilities where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 SIGN INSTALLATION Install project identification sign within 30 days after date fixed by Notice to Proceed. Install job construction signs as required and directed by the Engineer.

Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings. Install sign surface plumb and level, with butt joints to anchor securely.

Paint all exposed surfaces of sign, supports and framing.

3.3 TEMPORARY UTILITY INSTALLATION. Engage the appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with all utility companies' recommendations.

> Arrange with utility company and existing users for a time when service can be interrupted, if necessary, to make connections for temporary services.
>
> Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.

Obtain easements to bring temporary utilities to the site where the Owner's easements cannot be used for that purpose.

Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer. Neither the Owner nor Engineer will accept cost or use charges as a basis of claims for Charge Orders.

Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use. Sterilize temporary water piping prior to use.

Provide weatherproof, grounded-temporary electric power service and distribution systems of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switchgear.

Install electric power service underground, except where overhead service must be used. Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, ac 20 Ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance

Provide temporary lighting with local switching. Install and operate temporary lighting that will fulfill security and protection requirements without operating the entire system. Provide temporary lighting that will provide adequate illumination for construction operations and traffic conditions.

Provide temporary heat required by construction activities for curing or drying of completed installations or for protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce the ambient condition required and minimize consumption of energy.

Except where the Owner authorizes use of the permanent system, provide vented, self-contained, LP-gas or fuel-oil heaters with individual space thermostatic control. Use of gasoline-burning space heaters, open flame, or salamander heating units is prohibited.

Provide temporary telephone service throughout the construction period for all personnel engaged in construction activities. Install telephone on a separate line for each temporary office and first-aid station. At each telephone, post a list of important telephone numbers. Provide additional separate telephone lines for the following:

Where an office has more than 2 occupants, install a telephone for each additional occupant or pair of occupants.

Provide a dedicated telephone line for a fax machine in the field office

Provide a separate line for the Owner’s use.

Sanitary facilities shall include temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve the Project’s needs. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Provide covered waste containers for used material. Use the Owner’s existing toilet facilities will not be permitted. Install self-contained toilet units. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted. Provide separate facilities for male and female personnel.

Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for a healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.

Provide drinking-water fountains where indicated, including paper cup supply. Provide containerized, tap-dispenser, bottled-water drinking–water units, including paper supply. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45-55 degrees F (7-13 degrees C).

Provide temporary connections to sewers. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminates. Connect temporary sewers to the municipal system, as directed by Owner. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. Restore normal conditions promptly.

Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.

3.4 TEMPORARY PAVING. Construct and maintain temporary roads and paving to support the indicated loading adequately and to withstand exposure to traffic during the construction period. Locate temporary paving for roads, storage areas, and parking where the same permanent facilities will be located. Review proposed modifications to permanent paving with the Engineer.

Comply with Master Specification Division 1, Site Construction. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving. Install temporary paving to minimize the need to rework the installations and to result in permanent roads and paved areas without damage or deterioration when occupied by the Owner. Delay installation of the final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results. Extend temporary paving in and around the construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration, and supervision.

3.5 WASTE CONTROL. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when the temperature is expected to rise about 80 degrees F (27 degrees C). Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

End of Section

SECTION 01120

SECURITY

PART 1 – GENERAL

1.1 SCOPE. The Contractor shall be responsible for implementing a security program during construction to prevent unauthorized entry into the Work areas; theft of small tools, equipment and materials; and willful destruction of property. The Contractor shall coordinate security activities with DWSD's existing security program.

Where the work to be done is locked at an existing DWSD Facility, the area used by DWSD personnel outside of the construction limits, but within the overall plant grounds, shall be known as the restricted area. Where the work to be done is at a remote location, security will confirm to all portions of this section, except for specific plant security requirements

PART 2 - PRODUCTS

2.1 COMPUTER SECURITY. All personal computer systems shall be secured by cables, locks and pads.

PART 3 - EXECUTION

3.1 PLANT SECURITY. Unless otherwise provided in the Contract Documents or by specific direction and approval by DWSD's Chief of Security, all Contractor, sub-contractor, consultant, vendor, and supplier employees, officers, and agents shall park their vehicles in parking lots inside the fenced perimeter of the construction limits.

The Contractor and employees of the Contractor shall be exclusively responsible for the security, protection, and safety of all equipment, materials, vehicles, and persons located within the construction site fenced area.

All Contractor employees shall carry their hand tools with them and walk through the construction gate. DWSD identification must be shown.

All containers carried on or off the Site are subject to search. Inside the restricted area, employees may walk to their designated Work locations or the Contractor may arrange to transport employees in vehicles that the Contractor may continually keep on the Site.

Those persons who are not DWSD personnel shall have limited access to the restricted area. Persons who enter the DWSD Plant must report directly to and from their destination within the restricted area.

At the time of intended entry to the Plant, the security guard will notify the DWSD Plant employee that the visitor proposes to meet and the security guard will designate the location at which the visitor is to be received. The visitor shall notify DWSD plant employee and security guard prior to departure and obtain any DWSD property-clearance passes that may be required.

All persons and vehicles shall enter and exit the restricted area through the main gate. The Contractor, designer, subconsultant, and sub-contractor shall use no other gates or openings into the restricted area. Prior approval and security arrangements must be made for entry or exit at any location other than the main gates.

Any Contractor, designer, subconsultant, subcontractor, their officers, agents, employees, or other persons entering or exiting through unauthorized openings or found within the restricted area without proof of proper admittance shall be subject to arrest and prosecution for trespassing.

The Chief of Security and authorized agents will provide general security administration, and interpretation of this Section. The Chief of Security will issue any other security directives, orders, or notice that the Chief of Security may consider being necessary and appropriate.

DWSD's applicable executive staff will make any and all final determinations of which vehicles and persons may enter and exit the restricted area.

3.2 CONSTRUCTION SITE SECURITY. Access into and out of the construction work area will be controlled by the Contractor.

Entrance into the construction work area will be through a distinct and separate gate from the plant main gate where applicable. Security at this separate gate will be supplied by the Contractor at all hours that this gate is open. When the gate is secured to the construction work area at DWSD plants with a DWSD security force on duty 24 hours a day, security guards need not be provided by the Contractor.

The construction work area main gates shall use locks to which DWSD plant security has access.

3.3 SECURITY SERVICE. At construction sites without a DWSD security force on site, the Contractor shall, at his own expense, employ a uniformed guard service to provide a watchperson on site during all non-working hours.

3.4 PERSONNEL IDENTIFICATION. DWSD shall issue identification badges to all long term employees of the Contractor and Subcontractor that will be on site.

Contractor and subcontractor employees shall display identification badge at all times while inside the plant perimeter. Failure to do so is grounds for refusing entry at no additional cost to DWSD.

Contractor shall maintain a current list of Contractor and Subcontractor employees with badges and shall submit a copy to owner upon request. Identification badges will be returned at expiration of employee or subcontractor employment on site. Contractor shall be responsible to DWSD for positive control of employee identification badges.

3.5 CONTRACTOR VEHICLES. Contractor's vehicles shall be parked in the areas shown on the Construction Traffic Plan unless it is necessary for designated vehicles to deliver heavy supplies, heavy equipment, or heavy tools to the site.

The Contractor shall register with the security office all vehicles that will be used regularly within the existing plant restricted area. If appropriate, stickers will be issued for such vehicles.

The Contractor shall register with the security office all vehicles that will make deliveries at regular intervals to locations inside the operating plant restricted area. If appropriate, such vehicles will be issued one day passes for a specific destination at the site.

Unless otherwise provided in the Contract Documents or by specific direction and approval by DWSD's Chief of Security, private vehicles shall not be allowed or permitted entry to the restricted operation plant area on a regular basis.

Contractor's general superintendent and management personnel may be issued appropriate passes for a private vehicle to enter the restricted area if such persons can demonstrate a need for such a vehicle to perform their duties.

All vehicles are subject to search upon entry and exit from the restricted area. The Contractor's property must be clearly identified, designated, and declared prior to entry into the restricted area. Written registration of such tools and equipment may be required. Unless proof of ownership and authorization for exit from the restricted area are presented, tools and equipment as well as materials shall not be removed from the restricted area.

Neither extraneous nor unnecessary tools, equipment, or vehicles shall be allowed to enter the restricted area.

3.6 PROPERTY PASSES. Unless otherwise provided in the Contract Documents or unless an authenticated DWSD property-clearance pass is presented to the security guard, tools and equipment as well as materials shall not be removed from the restricted area. An authenticated DWSD property-clearance pass may be secured by Contractor demonstrating that such items were previously registered and have been brought into the restricted area as non-DWSD property that did not thereafter transfer to and became the property of DWSD.

If an authenticated DWSD property-clearance pass is not presented, the security guards will hold and maintain in their physical possession and control all such tools, equipment, or materials until positive identification and approval to remove such items can be established by the Contractor.

The Contractor will be informed by the Engineer of those designated DWSD persons who are authorized to issue and execute property-clearance passes.

End of Section

SECTION 01140

SOIL EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

1.1 SCOPE. This work includes the installation and maintenance of erosion and sedimentation controls required to prevent or minimize soil erosion and sedimentation from impacting the water resources of the State of Michigan and adjacent properties.

1.2 GENERAL.

1.2.01 Coordination. The Contractor shall conduct the work so that all soil, fuels, oils, bituminous materials, chemicals, sanitary sewage, debris and other unsuitable materials, resulting from the construction of the project, are confined within the right-of-way and project limits. These materials shall be properly disposed of to prevent them from leaving the project site and from entering watercourses, rivers, lakes, streams, reservoirs, wetlands or ground water.

1.2.02 Governing Standards.

Act 451 of 1994, Natural Resources and Environmental Protection Act, Part 91, Michigan Soil Erosion and Sedimentation Control (formerly PA 347 of 1972, as amended).

Michigan Department of Transportation (MDOT) Standard Specifications for Construction.

Wayne County Department of Public Services Engineering Division, Erosion and Sedimentation Control Standard Plan, dated April 17,1997.

Wayne County Department of Public Services Engineering Division, Special Provision for Erosion Controls, dated April 24, 1997.

Oakland County Department of Public Works, Erosion Control Manual.

1.3 QAULITY ASSURANCE. Soil Erosion and Sedimentation Control measures shall be installed and maintained in accordance with the requirements of all Federal, State and Local laws and regulations regarding soil erosion and sedimentation control, the Michigan Department of Environmental Quality (MDEQ), has designated the DWSD an Authorized Public Agency (APA) under authority of Act 451, Natural Resources and Environmental Protection Act, Part 91, Michigan Soil Erosion and Sedimentation Control (formerly PA 347 of 1972, as amended). The APA designation allows the DWSD to undertake earth change activities without obtaining an individual soil erosion permit. Failure by the Contractor to install and maintain adequate soil erosion controls may result in project shutdown and/or possible fines from the MDEQ. The Contractor is required to obtain an Act 451, Part 91 permit from the local soil erosion agency, as applicable and all other applicable Federal, State and local permits when working outside of DWSD right-of-way or outside DWSD acquired easement areas. A soil erosion permit is always required when the work disturbs more than 1 acre (4047 m^2) of land or is within 500 feet (152.4 m) of a lake or stream. Local Agency Act 451, Part 91 requirements may be more restrictive.

When conflict exists the more stringent requirement shall govern unless it adversely conflicts with agency having jurisdiction for which Engineer shall make the final determination.

1.4 SUBMITTALS. Even if a soil erosion permit is not required, Act 451, Part 91 requires a Soil Erosion and Sediment Control Plan be prepared as a part of the overall plan that will effectively reduce soil erosion and off-site sedimentation. The soil erosion and sedimentation control plan shall be implemented prior to commencing construction and shall contain at a minimum, the following information:

A map showing the site location, physical limits of each earth change activity, predominant land features including lakes, streams and wetlands, and contour intervals or slope information.

Soils information.

Location of existing and proposed drainage patterns.

Timing and sequence of each proposed earth change.

Description of all temporary and permanent erosion and sedimentation control measures.

A schedule for maintaining all control measures.

Any other information required by the permitting agency.

The Soil Erosion and Sediment Control Plan shall be in accordance with both the MDOT Standard Specifications for Construction and requirements of Agency having jurisdiction.

On projects requiring stream crossing or wetland permits from the MDEQ, the Engineer shall notify the regional MDEQ office of the anticipated construction start date. At project completion, the completion notification card attached to the permit must be submitted to the MDEQ. For projects requiring U.S. Army Corp of

Engineers or U.S. Coast Guard permits, the Engineer shall follow the notification procedures listed on those permits.

Contractor shall be responsible for proper implementation of erosion control measures with regard to construction timing and sequence of operations. Erosion control measures shall be repeated as often as necessary to satisfy permit conditions, Agency having jurisdiction and Engineer's requirements.

PART 2 – PRODUCTS

2.1 MATERIALS. Coarse aggregate shall meet the requirements for 6A aggregate as specified in Section 902 of the 1996 MDOT Standard Specifications for Construction. Additional acceptable materials as specified in the MDOT Standard Specifications include but are not limited to geotextile fabrics, rip-rap boulders, wood stakes, steel stakes, bracing screening, sand bags and standard sized wire bounded straw bales.

2.2 SILT FENCE. Polypropylene geotextile fabric, resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; meeting the following requirements:

2.2.01 Average Opening Size: 30 U.S. Std. Sieve (600 µm), maximum; ASTM D4751.

2.2.02 Permittivity: 0.05 sec^{-1}, minimum; ASTM D4491.

2.2.03 Ultraviolet Resistance: Retaining at least 70 percent of tensile strength; ASTM D4355 after 500 hours exposure.

2.2.04 Tensile Strength: 100 lb-f (445 N) minimum, in cross-machine direction; 124 lb-f (551 N) minimum in machine direction; ASTM D4632

2.2.05 Elongation: 15 to 30 percent; ASTM D4632.

2.2.06 Tear Strength: 55 lb-f (244 N) minimum; ASTM D4533

Posts shall be 2 by 2-inch (50 mm x 50 mm) cross section hardwood stakes, minimum 3-feet (1.0 m) long.

2.3 DEWATERING DISCHARGE FILTER BAG. UV-stabilized, non-woven geotextile bag to filter sediment from water prior to discharging. Geotextile fabric shall meet the following minimum average roll requirements:

2.3.01 Tensile Strength: 180 lb-f (200 N) minimum; ASTM D4632

2.3.02 Elongation: 50 percent minimum; ASTM D4632

2.3.03 Puncture Strength: 105 lb-f (667 N) minimum; ASTM D4833

2.3.04 Mullen Burst: 350 psi (2413 kPa) minimum; ASTM D3786-87

2.3.05 Trapezoidal Tear: 70 lb-f (310 N) minimum; ASTM D4533

2.3.06 Flow Rate: 80 gal/min/sf. (54 l/s/m^2) Minimum; ASTM D4491

2.3.07 Permittivity: 1.4 sec $^{-1}$ minimum; ASTM D4491

2.3.08 Apparent Opening Size: 100 U.S. Std. Sieve (150 µm) maximum; ASTM D4751

2.3.09 UV-Stability: 70% retained strength; ASTM D4355 after 500 hours.

2.4 TURBIDITY BARRIER. Geotextile fabric curtain suspended from flotation devices at the water surface and held in a vertical position by a ballast chain in the lower hem. Turbidity barrier curtain shall meet the following minimum requirements unless otherwise specified on the plans.

2.4.01 Consist of vinyl laminate on 1000 denier polyester fabric weighing 18 ounce per square yard (610 g/m^2) minimum.

2.4.02 Tensile strength of fabric shall be 220 lbs (100 kg) minimum.

2.4.03 Edges of fabric to be reinforced with minimum 5/8-inch (16 mm) diameter polypropylene rope.

2.4.04 Ballast chain minimum 5/16-inch (8 mm) galvanized steel.

2.4.05 Buoyancy blocks providing buoyancy of 18lbs/l.f (27 kg/m).

2.4.06 Length of curtain (water depth) 5-feet (1.5 m).

2.5 EROSION CONTROL BLANKETS. Machine produced blanket with a consistent thickness of evenly distributed straw or coconut fiber as specified. Unless otherwise specified on the Plans, the erosion control blanket shall have the following minimum properties:

2.5.01 Double net 100% straw blanket

2.5.02 Top and bottom photodegradable polypropylene netting, 1.64 lbs / 1,000 sft. (0.8 kg/ m^2) approximate weight.

2.5.03 100% agricultural straw 0.5 lbs. / sy. (.27 kg/m^2)

2.5.06 Stitch spacing: 1.5 inches (40 mm) on centers

2.5.07 Pegs shall be 6-inch (150 mm) long, hardwood pegs.

2.6 INLET FILTER FABRIC. The filter fabric shall be constructed of 100% continuous polyester needle-punched non-woven engineering fabric and follow the guidelines in the American Society for Testing and Materials (ASTM) D1117-99; Standard Guide for Evaluating Nonwoven Fabrics. The filter fabric shall be fabricated to provide a direct fit with the drainage structure cover. The filter fabric shall have the following minimum physical properties.

2.6.01 Tensile Strength: 80 lb-f (.355 kN) minimum; ASTM D4632

2.6.02 Elongation: 50 percent minimum; ASTM D4632

.6.03 Puncture Strength: 45 lb-f (200 kN) minimum; ASTM D4833

2.6.04 Mullen Burst: 350 psi (2413 kPa) minimum; ASTM D3786-87

2.6.05 Trapezoidal Tear: 70 lb-f (310 N) minimum; ASTM D4533

2.6.06 Flow Rate: 80 gal/min/sf. (54 $l/s/m^2$) Minimum; ASTM D4491

2.6.07 Permittivity: 1.4 sec^{-1} minimum; ASTM D4491

2.6.08 Apparent Opening Size: 100 U.S. Std. Sieve (150 µm) maximum; ASTM D4751

2.6.09 UV-Stability: 70% retained strength; ASTM D4355 after 500 hours.

PART 3 – EXECUTION

3.1 SERVICE CONDITIONS. Construction operations shall be conducted to prevent or minimize erosion and sedimentation. Temporary or permanent erosion and sedimentation controls shall be constructed and maintained as specified by agency having jurisdiction prior to commencing any construction operations including clearing. Grading operations shall be performed as soon as possible after clearing operations. Temporary erosion and sedimentation controls as directed by the Engineer shall be installed to minimize potential problems, to correct conditions which develop during construction, or to stabilize inactive construction areas. The Contractor shall minimize the area of unstabilized land surface over which storm water must flow. Construction shall proceed from lower ground toward higher ground, whenever possible.

Steps shall be taken to minimize erosive loss and resultant offsite sedimentation from stored piles of excavated spoils, topsoil, sand, gravel, and aggregate. Control methods used by the Contractor may include remote storage, covering, temporary stabilization, compacting, diversion ditches, and silt fences, in total in any combination, as may be dictated by the size, type, location, season and anticipated duration of storage.

Soil erosion control techniques such as ground cover in the form of vegetation and seeding, compaction, rip rap, or aggregate cover shall be used as appropriate to control erosion over large surface areas. Soil erosion control techniques such as weirs, check-dams, bank stabilization, sheet pilings, etc. shall be used to minimize soil erosion in streams and small waterways.

Provide suitable sedimentation control measures at affected connections to existing or new storm drains, to minimize deposition of sediment in the storm drains during the construction period. Sedimentation control measures shall be provided prior to any significant clearing, grading or surface disruption of the tributary areas.

Pumped water from well points, dewatering wells, or excavations shall not discharge onto unstabilized areas. Such discharge shall be conveyed by pipe, hose or stabilized channel, to a settling basin or other suitable sedimentation control facility.

3.1.01 <u>Time Limitations</u>. All graded areas shall be brought to final grade as soon as possible. Permanent soil erosion controls and stabilization for all slopes, channels, ditches and other disturbed areas shall be completed within 15 calendar days after final grading as required by law. Permanent restoration of all slopes and ditches within 164 ft. (50 m) of any lake, stream or wetland shall be done within 10 calendar days following final grading. Where it is not possible to permanently stabilize a disturbed area, appropriate temporary erosion and sedimentation controls shall be implemented within 15 calendar days after cessation of grading activity, or as directed, whether or not the area has been brought to final grade. All temporary soil erosion and sedimentation shall control measures be maintained until permanent soil erosion and sedimentation controls are in place and functional.

3.1.02 <u>Area Limitations</u>. The surface area of erodible earth material exposed at any one time will be limited to the minimum amount required for execution of the work. Typically this is the length of water main or sewer line that can be laid and backfilled in one day for cleaning and grading operations, or the minimum area needed to perform general site work activities. The Engineer may reduce or increase the limits of exposed surface area dependent on the Contractor’s capability to keep current the finish grading, top soiling, seeding, mulching, and other temporary or permanent erosion and sedimentation control operations.

When the Contractor has completed the permanent restoration on a cut slope or embankment slope, or portions thereof, the completed slope will be approved by the Engineer.

The Contractor shall not disturb lands and waters outside the grading limits unless such work is found necessary and is approved by the Engineer. Restoration of areas that are disturbed beyond the plan or approved limits will be at the Contractor's expense.

Prior to site disturbance when work is conducted outside the right-of-way, such as borrow operations, at waste or disposal areas, haul roads, storage sites or other types, the Contractor shall obtain and provide the Engineer with copies of any permit required by agency having jurisdiction. These permits shall include, but are not limited to those required under Act 451, Part 91 (Soil Erosion and Sedimentation Control), Part 303 (Wetlands Protection, formerly Act 203), Part 301 (Inland Lakes and Streams, formerly Act 346), Part 31, (Water Resources Protection, Floodplain Regulatory Authority, formerly Act 245 as amended by Act 167), and Part 31 (Water Resources Protection). National Pollutant Discharge Elimination System (NPDES), Federal Section 404 and Clean Water Act, permits may also be required. Temporary and permanent erosion and sedimentation controls shall be provided by the Contractor as specified in the applicable permits.

3.2 CONSTRUCTION OF EROSION AND SEDIMENTATION CONTROLS. Construction of temporary or permanent erosion and sedimentation controls shall meet the requirements as specified on the plans or as directed by Engineer.

If approved by the Engineer, and not prohibited by permit, broken concrete may be used for erosion and sedimentation controls provided all the reinforcing steel has been removed or flush cut. The use of bituminous material for checkdams, weirs or riprap is prohibited.

3.2.01 Filter Bag. This work shall consist of furnishing, placing, and disposing of a minimum 269 ft^2 (25 m^2) filter bag constructed of geotextile blanket. Water pumped from construction operations shall be pumped into and allowed to filter through the filter bag before entering any watercourse. A separate silt fence shall be installed around the filter bag for additional protection in sensitive areas or where the filter bag is not effectively removing the sediment. Water being pumped may be discharged directly into the watercourse provided it remains silt free. The filter bag should be located on level ground above the banks of the stream channel. The location of the filter bag will be approved by the Engineer. The filter bag and its contents shall be properly disposed of by the Contractor.

3.2.02 Silt Fence. This work shall consist of furnishing, erecting, maintaining, removing, and disposing of a silt fence. Silt fencing consists of a post supported geotextile. Installation, including proper entrenching, shall be accomplished as specified or approved according to the manufacturer's published recommended practice. Sections of silt fence shall be overlapped at least 3.3 ft (1 m). In areas where water ponds are located behind the silt fence, a stone filter may be needed to outlet the water and prevent failure.

3.2.03 Sediment Traps and Basins. This work shall consist of excavating, maintaining and filling in if directed, a sediment trap 176 ft^3 (5 m^3) or less in size or a sediment basin greater than 176 ft^3 (5 m^3) as shown on the plans or where directed.

The excavated material shall not be allowed to erode into a lake, watercourse, or wetland. Check dams or weirs that are to be installed at the downstream side of the trap or basin should be installed prior to the excavation of the sediment trap or basin. Sediment traps shall be in place immediately prior to beginning construction or as directed by the Engineer.

3.2.04 Erosion Control Blankets. Shall consist of a machine produced mat of curled wood exterior of 80 percent 6 inch (15.2 cm) or longer fiber length with a consistent width of fiber evenly distributed throughout the mat. A photodegradable netting manufactured from extruded plastic mesh shall be used on the top side of the excelsior erosion control blankets, the blankets shall be smolder resistant with no chemical additives.

3.2.05 Check Dams and Weirs. This work shall consist of installing, maintaining and removing if directed, a check dam or weir across a ditch or watercourse. The cross-section and installation shall be as shown on the plans or as directed. The check dam or weir shall extend at least 16 inch (40.6 cm) up the slope on both sides and shall include a 4 to 5 inch (10.16 to 12.7 cm) lower center channel spillway. Check dams shall be constructed as indicated on plans or immediately after grading in the area is completed. Weirs shall be constructed prior to any construction affecting the waterway is started.

3.2.05 Temporary Channel Liner. This work shall consist of furnishing, installing, maintaining, removing, and disposing of a temporary channel liner. The liner shall be either a plastic sheeting or a Polyvinyl Chloride (PVC) material. The PVC material must be used between November 15 and March 1 or when frozen conditions are expected. The temporary channel liner shall extend over the berm along the top of the temporary channel and be anchored. Sections of temporary channel liner shall be overlapped 20 inches (500 mm) in the downstream direction and have a sufficient quantity of washed 6A stone placed in the overlap area to prevent undermining of the liner.

3.2.06 Stone or Gravel Filter at Inlet. The Stone or Gravel Filter shall be constructed immediately after the backfilling and grading adjacent to the inlet is completed. The number of sides of the filter may vary depending upon the location and type of intake structure.

3.3 MAINTENANCE OF EROSION AND SEDIMENTATION CONTROLS. The Contractor shall maintain all temporary erosion and sedimentation controls during the period that the temporary controls are required and all permanent erosion controls until the contract has been completed and accepted. Such maintenance shall consist of the repair of all damaged areas, replacement of lost facilities and periodic removal of sediment. Sediment traps and basins shall be cleaned out when they are half full or as directed. Sediment or debris shall be removed from in front of silt fence when it has accumulated to one half of the fence height. The removed sediment shall be disposed of according to Subsection 205.03.A.4 of MDOT 1996 Standard Specifications for Construction.

Any accumulation of sediment affecting the efficient operation of the erosion controls should be removed and stockpiled in a stabilized area so as to prevent the material from eroding back into the drainage course.

3.4 REMOVAL OF EROSION AND SEDIMENTATION CONTROL FACILITIES. Temporary erosion and sedimentation controls shall be removed or obliterated when the permanent controls are in place and approved, unless ordered to be left in place by the Engineer. Temporary controls adjacent to lakes, watercourses, or wetlands shall be left in place until the adjacent slopes have turf establishment. Mulch placed for temporary erosion control shall be incorporated into the slope, or removed, prior to placement of topsoil, permanent seeding and fertilizing operations. Care shall be exercised during removal of erosion controls to minimize erosion or sedimentation into watercourses. Any damage caused during the removal operations shall be repaired at the Contractor’s expense.

After the upstream construction is completed and vegetation or a permanent lining has been established in the waterway, the sediment pit shall be filled, the sediment trap removed and the side slope area formerly occupied by the sediment trap sodded or riprapped, as directed by the Engineer.

After vegetation or a permanent lining has been successfully established in the ditches and/or swales, the check dams shall be removed and the area formerly occupied by the check dam shall be sodded as applicable.

After construction is completed and the waterway channel restored, the weirs shall be removed and the area formerly occupied by the weir shall be restored.

After vegetation or a permanent lining has been successfully established in the ditches or swales, the stone or gravel filter at inlet shall be removed and the area formerly occupied by the filter shall be sodded.

Sand filled bags must be disposed of at an upland site or as approved. If approved, stone from stone filled bags may be placed in the bottom of the watercourse if the stream hydraulics are not changed.

End of Section

SECTION 01150

PROJECT RECORD DOCUMENTS AND PHOTOGRAPHS

PART 1 - GENERAL

1.1 SCOPE. This section describes the Contractor's responsibility to provide record documents, construction photographs, and digital video of the Work. This section builds upon the General Conditions (Exhibit C) of the Agreement.

1.1.01 Record Documents. During the construction period, Contractor shall maintain a complete set of project record documents in the project field office for transmittal to Engineer and completion of project. This set is in addition to the construction set used by the Contractor. The record set will not be used for construction. The record documents shall include:

Contract Documents

Construction Documents

Contract Addenda

Change Orders and other Modifications to the Contract

Engineer's Field Orders or Written Instructions

Approved Shop Drawings, Working Drawings and Samples

Field Test Records

Construction Photographs and DVDs

Progress Schedule

1.1.02 Construction Photographs. Provide photographs and DVD's made of the Work from views and at such times as directed by the Engineer.

The photographic and video work shall be done by a responsible commercial photographic studio known to be skilled and regularly engaged in the business of taking commercial photographs.

Electronic "snap-shot" photography shall also be used as necessary to record and facilitate resolution of on-site issues through the transmission of electronic photographs by e-mail from the site to the Designer's and Engineer's offices.

1.2 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES. Store documents and samples in Contractor's field offices apart from documents used for day-to-day management of construction. Record documents shall not be used for construction purposes.

Provide files and racks for storage of record documents and a locked cabinet or secure storage space for storage of samples. Maintain documents in a clean, dry, legible condition and in good order.

The Contractor shall institute a computerized record control program utilizing, or compatible with, Engineer software.

Documents and samples shall be available at all times for inspection by the Engineer. As a prerequisite for milestone progress payments, the Contractor shall submit the currently updated “Record Documents” for review by the Engineer and Owner.

1.3 PHOTOGRAPHIC REQUIREMENTS. Provide photographs taken at each of the major location of major CPM activities during construction.

Photographs shall be in color. Provide 500 professional photographs taken at various stages of the project as directed by the Engineer unless indicated otherwise. These photographs shall represent a visual history of the Project, from Contract award through occupancy.

Provide scaled, color aerial photographs of the project site; one photograph will be of the project within 60 days after notice to start work; and one photograph shall be within 60 days after project start-up and demolition are completed. The photograph scale shall be 1inch =100 ft (1 cm = 1/100 m). The photograph shall be an aerial composite made up of a sufficient number of segments to ensure that all project structures appear free of distortion.

Provide digital electronic images of all photographs on CDs as well as three prints and negatives of each view. Deliver digital electronic images and prints, to the Engineer.

1.4 RECORDING. Use colored felt tip marking pens for recording information in the color code designated by the Engineer.

Label each document "PROJECT RECORD" in neat large printed letters and all standard document information, Contract name and number, location, specification number or spectext section, etc. Record information concurrently with construction progress. Do not conceal any Work until required information is recorded.

1.4.01 Drawings. Legibly mark the following information onto as-built drawing to record actual construction:

Depths of various elements of foundation in relation to finish first floor drain.

All underground piping with elevations and dimensions. Changes to piping location. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements. Actual installed pipe material, class etc.

Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of the structure.

Field changes.

Changes made by Field Order or by Change Order.

Details not on original contract drawings.

Equipment and piping locations, and relocations.

Major architectural and structural changes including relocation of doors, windows, and etc.

Architectural schedule changes according to Contractor's records and shop drawings.

Transfer all marks to the CAD drawing file and submit a final magnetic media record as well as a final plot on mylar of all updated as-built drawings. In addition, the Contractor shall provide DWSD with ten (10) full size (24"x36") hard copies and ten (10) CDs of the final as-built drawings.

As-built drawings shall be computerized and made available on-line to the control system operators.

1.4.02 Specifications and Addenda. Legibly mark each Section to record the manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed, and changes made by Field Order or Change Order.

1.4.03 Shop Drawings. Label shop drawings with "PROJECT RECORD" and rest of information as shown above. Refer to Master Specification Section 01080, Project Submittals for additional information on format.

1.5 SUBMITTAL. On completion of the Work, and prior to final payment by DWSD, the Contractor shall arrange the project records in order to match the Specifications Sections of the Project/Contract, bind them together, index them and deliver them to the Engineer.

The Contractor shall review the records maintained by its sub-contractors for completeness prior to assembly and submittal.

Tracings of all Construction Documents and Shop Drawings made by the Contractor, sub-contractors, and suppliers of materials or equipment shall be corrected to show the Work as actually completed or installed.

Furnish a mylar copy, two xerographic prints, and magnetic media for each corrected and approved drawing.

Accompany each submittal with transmittal letter in duplicate, containing:

Date

Project title and number

Contractor's name and addresses

Title and number of reach record document

Signature of Contractor or its authorized representative

Contract section and subsection numbers

Location

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MATERIALS. The film negative shall be not less than 4 x 5 inches (10.16 x 12.7cm).

Each print shall be single weight paper with glossy finish and the overall dimension shall be 7-1/2 x 10 inches (19.05 x 25.4 cm). The print shall be clear, sharp and free of distortion after the enlargement from the negative.

Provide loose-leaf albums for each set of photographs to hold prints with a maximum of 50 leaves per binder. The binder shall be Boorum and Pease No. 352, National No. 75-681, or equal.

Each print shall be protected by a flexible, transparent acetate or plastic sheet protectors with metal reinforced holes which shall fully enclose each print. One edge of each leaf shall be capable of being inserted in the rings of the album. Two extra leaves shall be provided in each binder. Durable blank loose leaf sheets, fitting the album, shall be furnished with each album so the final indexing of all photographs and their description will be recorded and permanently inserted with the photographs. The sheet protector shall be Boorum and Pease model 51780 or equal.

The Contractor shall provide two sets of slides of each view in trays. The slide trays shall be Elmo 4000-1CBK or equal.

All video of the Work shall be provided on digital media such as DVD, in a format acceptable to the Contracting Officer.

Each aerial photographic print shall be double-weight paper with glossy finish and shall have overall dimensions of 36 inches x 58 inches (91.4 cm x 147.3 cm). The Contractor shall provide 24 full size prints (12 prints of the site within 60 days of notice to start and 12 prints of the site within 60 days after plant start-up is completed) and 36 inches x 58 inches (91.4 cm x 147.3 cm) negatives, one for each aerial photograph.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS. Photographs shall be of correct exposure and focus, displaying high resolution and sharpness; maximum depth of field.

3.2 PHOTOGRAPHY VIEWS REQUIRED. Photograph shall be from locations to illustrate condition of construction and state of progress adequately. Prior to the beginning of construction identify and obtain Engineer's approval of a vantage point that will capture the entire construction site. Provide recurring photographs from the location throughout construction. Consult with Engineer each occasion for instruction covering views required.

The Contractor shall provide before and after photographs of each portion of the site. The below ground facilities shall include all equipment, walls, floor, piping, supports and entrance. At major locations, photographs shall include before, during, and after prints and all prints shall be placed in binders in ascending date order to show the Work as it progresses.

3.3 DESCRIPTIVE INFORMATION. Each photograph shall have a permanent title block on the back and shall contain the typed information and arrangement as follows:

> DETROIT WATER AND SEWERAGE DEPARTMENT
> Contract No: (List Contract No)
> (Title of This Contract/Program Element)
> CONTRACTOR: (Name of Contractor)
> DATE: (When photo was taken)
> PHOTO NO: (Consecutive Numbers)
> PHOTO BY: (Firm Name of Photographer)
> LOCATION: (Description of Location and View)

The Contractor shall provide the Engineer with a written description of each photograph and slide. This description shall be included in the binders and copy shall be submitted with negatives and slides. The field engineer or inspector shall approve the description.

3.4 DVD REQUIREMENTS.

3.4.01 Major Locations. The Contractor shall provide color DVD's of the construction site and each major facility and structure adjacent to the construction before construction starts, during construction and when construction has been completed. Approximately every two weeks, 15 minutes of video recording shall be submitted to the Engineer showing Work completed, Work in progress, Work started, and problems which occurred since last taping. The Contractor shall maintain the master DVD of each portion of the facility on Work site. The master DVD is a running chronicle of construction. The Contractor shall "dub" the bi-weekly video recording on to the master DVD. The bi-weekly DVD's shall be submitted to the Engineer within ten (10) working days after video recording and the bi-weekly DVD's may include multiple locations.

All video recording shall be filmed with date and stamp showing on each frame of film. During video recording , the Contractor shall narrate the video explaining what is being shown, the problem that has occurred and what is being done. All master DVD's shall be delivered to the Engineer, within five working days after "Certification of Substantial Completion" is submitted.

3.5 DIGITAL PHOTO DOCUMENTATION.

Catalog and manage Electronic "snap-shots" and images of photographs in a secure digital photo management system capable of being linked to the project schedule and document management database. Add captions, descriptions, and key words. Transfer a copy of all "snap-shots" and photos with their related notes, keywords, captions and activity ID's to the Engineer on a weekly basis. Provide three copies of the digital photo management system with software to the Engineer. Turn over digital camera and master digital photo management software to Owner at final completion

The print shall be clear, sharp and free of distortion after enlargement from the negative. Each photograph shall have a permanent title block in the lower right-hand corner which shall be 2 1/2 inches (6.4 cm) high by 6 inches (15.3 cm) wide and shall contain the "Leroy" template lettered information and arrangement as follows:

DETROIT WATER AND SEWERAGE DEPARTMENT
(Project Title)
(Project Address)
SCALE: 1" = 100'-0" (1 cm = 1/100 m)
PHOTO BY: (Firm Name of Photographer)
DATE: (When photo was taken)

End of Section

SECTION 01160

TRAINING AND OPERATION & MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SCOPE. This section provides requirements for furnishing Operation and Maintenance (O & M) Manual data with necessary related information and providing associated training.

1.2 GENERAL.

1.2.01 O & M Manual Requirements. Prepare operating and maintenance data as specified in this Section and as referenced in other pertinent sections of the Specifications. The data presented in the O & M Manuals shall be specifically related to equipment, electrical, mechanical, instrumentation, communication, and other systems of this Contract and application.

The Contractor shall furnish all labor, equipment, materials, and all other items to supply and deliver, to the Engineer, O & M Manuals for the Work in accordance with the requirements of this Section. Request and incorporate maintenance and operation data furnished by DWSD.

The costs of the O & M Manuals shall be included in the total Contract Price.

1.2.02 Training Requirements. Instruct and train Owner's personnel in operation and maintenance of equipment and systems supplied and/or installed under this contract.

Incorporate the following operation and maintenance data and training services furnished by suppliers into the training program:

Shop drawings.

Equipment manuals.

Start-up services.

Training as specified in detailed specification sections.

Prepare instructor materials and student notes/guides required for complete factory, field, classroom and hands-on training. Furnish training videotapes for all equipment provided under this contract.

Include in contract price the cost for preparing Training Manuals, conducting classroom instructions, performing field, factory and hands-on training and all other activities required to provide a comprehensive training program as specified herein.

1.3 QUALITY ASSURANCE. Preparation of O & M Manual data and training materials shall be done by personnel:

Trained and experienced in maintenance and operation of equipment and systems installed under this contract.

Familiar with requirements of this Section and training requirements of DWSD.

Skilled as technical writer to the extent required to communicate essential data

Skilled as draftsman competent to prepare required drawings

Furnish resumes, including three outside references for each instructor to be used in the training program.

The Engineer will review the resumes. Based upon a review of resumes and contacts with references, the Engineer will approve, request additional information, or reject proposed instructors for the training program. If the proposed instructor is rejected, the Contractor shall submit a resume and references on an alternate instructor for acceptance by the Engineer.

1.4 MANUAL FORMATS.

1.4.01 O & M Manuals. Where systems are furnished and/or assembled by manufacturers, contractors, or subcontractors, component manuals are required herein. In addition, the Contractor shall provide a Master Index of Component O&M manuals.

The Operation and Maintenance Manuals shall include:

Description of the system components(s), including diagram and exploded views.

Explanation of start-up, shutdown, normal operating and malfunctioning aspects of each component of the system.

Tabulation of a lubrication schedule.

Description of preventive maintenance checking procedures.

Cross-reference to all other individual component manuals.

Storage requirements.

Diagrams and exploded views of equipment and each component of the system.

Installation instructions.

Alignment instructions and tolerances.

Operating instructions.

Troubleshooting instructions.

Maintenance instructions.

Recommended spare parts list and how to obtain same.

Valve and instrument list.

O & M Manuals shall be prepared on 8 1/2 x 11inch (21.6 cm x 27.94 cm) size, 20-lb (9 kg) minimum, white paper for the final submittal. Preliminary copies shall be prepared on colored paper to be distinctive. Text shall be Manufacturer's printed data, or neatly word-processed. Each section shall be separated by indexed tabs.

Drawings shall be in binders with text. Reduce larger drawings and fold to size of text pages but not larger than 11 x 17 inch (27.94 cm x 43.18 cm). All drawings shall be placed at the end of each section and shall be printed on one side only. Sections shall be separated by reinforced, punched binder tabs. Provide a flyleaf for each separate product, or each piece of operational equipment.

Binders shall not be filled to more than 75 percent capacity. When multiple binders are used, arrange the data into related consistent groupings. DWSD will provide sample of required binder. Binders of 1 inch (2.54 cm) thickness are preferred. Binders shall not exceed 2 inches (5.1 cm) in thickness.

Provide word-processed description of product, and major component parts of equipment.

On the cover of each manual, identify each volume with typed or printed title, "OPERATION & MAINTENACE INSTRUCTIONS", listing:

Title of Project and DWSD Contract Number.

Identity of separate structure as applicable.

Identity of general subject matter covered in the manual.

In addition to hard copies, provide two copies of all electronic media. Provide an original word-processed disk of the information to the Engineer and provide the other copy of word processed disk to DWSD Document Control.

All word processing must be done using the latest version of MS Word or word processing software, or as approved by the Owner, that is congruent file format with word processing in Document Control at time of transmittal of documents.

All drawings except control system configuration drawings must be submitted on disk using CAD.

The O & M Manuals shall be computerized and be made available on-line to the control system operators.

1.4.02 Training Manuals. Prepare training packages in form of an instruction manual for use by Owner’s personnel. Submit training packages for approval to the Engineer.

Training Manuals shall be prepared on 8 1/2 x 11 inch (21.6 cm x 27.94 cm) size, 20-lb (9 kg) minimum, white paper. Text shall be Manufacturer's printed data, or neatly word-processed. Each section shall be separated by indexed tabs. Training Manuals shall contain table of contents, pretest, learning objectives, and general operations of specific equipment information.

Drawings shall be in binders with text. Reduce larger drawings and fold to size of text pages but not larger than 11 x 17 inch (27.94 cm x 43.18 cm). All drawings shall be placed at end of each section and shall be printed on one side only. Sections shall be separated by reinforced, punched binder tabs. Provide a flyleaf for each separate product, or each piece of operational equipment.

On each binder cover, identify project and volume titles and general subject matter covered in manual.

Binders shall be commercial quality, three-post binders with durable and cleanable plastic covers. Binders shall include title pockets for holding notes. Binders shall have a maximum post width of 2 inches (5 cm). When multiple binders are used, correlate the information into related consistent groupings.

1.5 TRAINING.

1.5.01 Training Submittals. Submit ten (10) copies of the preliminary draft detailed outline of proposed training program to the Engineer within ninety (90) days after Notice to Start Work.

The outline will be reviewed by the Engineer and Owner’s personnel and comments returned to the Contractor.

A revised training program outline shall be submitted to the Engineer within thirty (30) days after receiving the comments from the Engineer.

After the detailed outline is approved by the Engineer and at least thirty (30) days prior to classroom training, all training manuals shall be submitted and resubmitted (if needed) for DWSD’s review and approval. Copies of approved training manuals shall be provided to all trainees.

Submit the original DVD and two (2) copies of the DVD within 45 days of completion of on-site training. Contractor shall submit information in accordance with Master Specification Section 1080, Project Submittals.

1.5.02 <u>Owner’s Facilities For Training</u>. Where feasible and approved by Engineer. use the Owner’s training facilities for all specified field training programs. Use of the Owner’s facilities shall be coordinated with the Engineer. If Engineer identifies that Contractor’s proposed training facilities are inadequate, Contractor shall coordinate with and provide to Engineer alternate training facilities at no additional cost.

1.5.03 <u>Schedule For Conducting Training</u>. All factory training programs, if required, shall be completed prior to start-up of the Owner’s system and shall use equipment similar and acceptable to the Owner’s equipment.

The training programs shall be conducted before acceptance testing begins or as approved by the Owner.

Up to forty (40) individuals for operating and up to forty (40) individuals for maintenance, unless indicated otherwise, will require training. These individuals shall be trained in small groups Mondays through Fridays, during each shift.

Separate training programs shall be planned and conducted for maintenance of instrumentation, maintenance of process equipment, and operation of process equipment. The training site shall be suitable in all respects for training including seating, lighting, noise, HVAC, and equipment for “hands on” training.
The hands-on training shall be conducted with a maximum of five (5) students per instructor.

1.5.04 <u>Videotaped Training Material</u>. Produce or provide video taped training material, subject to approval of Owner, for all training described below. Furnish videotapes compatible for use with the Owner’s videotaping equipment. Include factory or studio-produced set of materials and/or videotapes of on-site training as appropriate and as acceptable to the Engineer.

Label videotape cassettes with the following information:

Name and number of construction contract.

Name of Contractor.

Subject matter of tape.

Equipment item or system.

Manufacturer of equipment or system.

Date of production of videotape.

Prepare and submit an index of all videotapes, with a numbering system categorized according to subject matter.

All costs associated with production and provision of the videotapes, shall be borne by the Contractor.

1.5.05 Instrumentation Training and Maintenance. Train the Owner’s maintenance personnel to be able to do the following:

Describe the overall function of each instrument and control loop installed under this Contract.

Locate the probable source of a malfunction in the instrumentation equipment and control loops, determine the symptoms of the trouble, establish the probable cause and affect a solution.

Take appropriate preventive and corrective maintenance procedures necessary to keep the instrumentation system in proper operating condition, including calibration and tests.

Course materials to be used for training Owner’s maintenance personnel shall include:

Instrumentation videotapes as described earlier in this Section.

Pertinent portions of the submittals specified in the specifications such as loop diagrams, calibration data and maintenance instructions.

Detailed course outlines and trouble shooting guide for field use. The trouble shooting guides shall include symptoms, probable causes and solutions for cases of trouble described during the training program.

Effectiveness of training maintenance personnel shall be determined through written and in-the-field skills evaluation to the trainees at the completion of each segment of formal instruction and hands-on training. The performance of each of the personnel shall be classified as "satisfactory" (demonstrates basic knowledge and performance of standard maintenance procedures) or "unsatisfactory" (requires more training to demonstrate basic knowledge and performance of standard maintenance procedures). All unsatisfactory evaluations shall include recommendations for corrective action.

The training program shall not include the time required for system start-up instruction or the acceptance test.

1.5.06 Training For Maintenance Of Process Equipment. Train the Owner's maintenance personnel to be able to do the following:

Describe the functions of the process equipment installed under this Contract.

Perform component preventive and corrective maintenance activities required to keep unit equipment in good operating condition.

Locate the probable source of equipment malfunctions, determine the symptoms of the trouble, establish the probable cause, and affect a solution.

Course materials to be used for training Owner's maintenance personnel shall include:

Equipment videotapes as described earlier in this Section.

Pertinent portions of the O & M Manuals as well as alignment tolerances, lubrication schedules, vibration analysis instructions, vibration analysis parameters, and special calibration test and procedures.

Detailed course outlines and troubleshooting guides for each piece of equipment installed under this Contract. The troubleshooting guides shall include symptoms, probable causes, and solutions for all cases of trouble described during the training program.

Method of training maintenance personnel shall include the Contractor using the Owner's equipment to demonstrate troubleshooting, preventive and corrective maintenance procedures.

Effectiveness of training maintenance personnel shall be assessed through written and skills evaluations of each piece of equipment to the trainees. The performance of each trainee shall be classified as "satisfactory" (demonstrates basic performance of standard maintenance procedures) or "unsatisfactory (requires more training to demonstrate basic products). All unsatisfactory evaluations shall include recommendations for corrective action.

The field training program shall not include the time required for system startup instruction or the acceptance test.

1.5.07 Training For Operation Of Process Equipment. Train the Owner's operations personnel by describing the functions of the equipment installed under this Contract. Include how the components of a system are controlled together and what the efforts of the control methods are on the system. Consider both upstream and downstream processes installed under this Contract.

Train personnel to be able to implement start-up and shutdown procedures for each piece of equipment individually, as well as the start-up and shutdown of the systems comprising the equipment. This instruction shall include normal operation, alternative operations, and emergency operations.

Operations personnel should understand the functions of the instrumentation installed under this Contract, describing the individual components and how each component is used in monitoring and/or controlling equipment and/or processes installed under this Contract. They should understand the operating modes possible as a result of the installations made under this Contract.

Operations personnel will be trained to locate the probable source of system inefficiency, determine the symptoms, establish the probable cause, and re-stabilize system efficiency for systems installed under this Contract.

Training shall include taking necessary precautions for safe operation of the equipment, instrumentation, and control system as well as emergency procedures for equipment and systems installed under this Contract.

Course materials to be used for training Owner's operation personnel include:

> Process control videotapes as described earlier in this Section.
>
> Pertinent portions of the O & M Manuals, including start-up procedures, shutdown procedures, descriptions of equipment, instrumentation functions, modes of operations, control and monitoring instructions, trouble-shooting instructions and process control instructions.
>
> Detailed course outlines and operations guides for equipment and processes for field use. The operations guide shall include general, start-up, shutdown, optimization, and emergency operating procedures.

Methods of training Owner's operations personnel shall include a field training program at the Owner's site consisting of classrooms and hands-on training using the Owner’s equipment and systems.

Effectiveness of training operations personnel shall be assessed through written and in-the-field skills evaluation to the trainees. The evaluations shall be designed to determine the trainees’ ability to control the processes, as well as their ability to operate the equipment. The performance of each trainee shall be classified as “satisfactory-operations” (demonstrates basic knowledge and performance of standard operating procedures) or “unsatisfactory-operations’ (demonstrates basic knowledge and performance of process control strategies), or “unsatisfactory-process” (requires more training to demonstrate basic knowledge and performance of process control strategies). All unsatisfactory evaluations shall include recommendations for corrective action.

The field training program shall not include the time required for system start-up instructions or the acceptance test.

1.6 O & M MANUAL CONTENTS BY VOLUME. Neatly word-processed table of contents for each volume, arranged in systematic order, shall include the following:

Contractor, name of responsible principal, address, fax number, and telephone number.

A list of products required to be included, indexed to content of the volume.

For each product list name, address, fax number and telephone number of subcontractor or installer.

Identify area of responsibility of each sub-contractor or installer.

Identify local source of supply for parts and replacement.

Identify each product by product name and other identifying symbols as set forth in Contract Documents.

All sheets, pages, drawings, and etc. shall have ID printed on it including Contract number, volume name, and number and location.

1.6.01 Product Data. Include only those sheets that are pertinent to the specific product. Annotate each sheet to clearly identify specific product or part installed, data references applicable and delete data references not applicable for this installation.

1.6.02 Drawings. Supplement product data with drawings as necessary to illustrate clearly the relations of component parts of equipment, systems, control and flow diagrams. Include DWSD Tag Numbers.

Coordinate drawings with information in Master Specification Section 1150, Project Record Documents and photographs, to assure correct illustration of completed installation.

Project Record Documents shall not be used as maintenance drawings.

1.6.03 Written text to supplement product data for specific installations. Organize in consistent format under separate headings for different procedures. Provide logical sequence of instructions for each procedure. Describe how complete system is to operate.

1.6.04 Warranty, Bond & Service Contracts. Provide copies of pertinent information related to each warranty, bond, and service Contract issued. Provide information sheet for DWSD's personnel that explain proper procedures in event of failure and provides instances that might affect validity of warranties or bonds.

1.6.05 Training Manuals. Training Manuals used in training courses shall become part of the O & M Manual.

1.7 MATERIALS & FINISHES MANUAL. Provide manual that details architectural products, applied materials, and finishes for the project. Include the following information:

Manufacturer's data, giving full information on products.

Catalog number, size, composition.

Color and texture designations.

Information required for re-ordering special-manufactured products.

Instructions for care and maintenance.

Manufacturer's recommendation for types of cleaning agents and methods.

Cautions against cleaning agents and methods that are detrimental to product.

Content, for moisture-protected and weather-exposed products:

Manufacturer's data and applicable standards.

Chemical composition.

Details of installation.

Recommended schedules and instructions for inspection cleaning, maintenance and repair.

Additional requirements for maintenance data as required by other sections of the Specifications.

1.8 COMPONENT SYSTEMS MANUALS. A separate O & M Manual volume is required for each system including electrical, mechanical, instrumentation, communication and other packaged systems as identified by contract documents.

1.8.01 Descriptive Contents. Each manual shall include a table identifying each piece of equipment, each associated control or instrument, location of the equipment, location of control or instrument and the function of each equipment, control or instrument. The manual shall detail the following detailed descriptions:

Charts of equipment, systems, component parts, model number, name plate data, assembly drawings, and tag numbers with location and function of each piece of equipment, instrument or valve.

Function, normal operating characteristics, and limiting conditions for both the system, sub-system and the component parts.

Performance curves, engineering data and tests.

Complete nomenclature and commercial number of replaceable parts.

Circuit directories of panel boards, electrical service, controls and communications.

As-installed color-coded wiring diagrams.

Instrument loop diagrams showing the path that a control or instrumentation signal takes from its origin to the action it takes.

An electrical schematic for each item as installed.

A chart listing the controls/instruments in a loop identifying the equipment's abbreviated symbol, a description of the symbol, design criteria, process flow, quantity supplied, and manufacturer's model and serial number.

List of special tools required to service equipment and/or systems including where they are stored.

Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

Predicted life of parts subject to wear.

Items recommended to be stocked as spare parts.

As-installed control diagrams.

Each Contractor's coordination drawings.

Reference drawing which shows equipment, instrument or valve location.

Manufacturer's model and serial number.

Valve actuator type (manual, hydraulic, electric or pneumatic).

Local services (process water and air, drains, HVAC, natural gas and steam).

1.8.02 Operations Content. The manuals shall detail the following operational descriptions:

Routine, normal, summer, winter, special, abnormal and emergency O & M instructions to include sequences required.

Regulation, control, setting, stopping, shut-down, and emergency instructions.

Disassembly, repair, re-assembly, alignment, adjustment and checking equipment.

Manufacturer's printed operating and maintenance instructions.

List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

Procedures to handle potential overloads, power outage, and breakdown.

Identify alarms by equipment location and action to correct.

Equipment safety features, requirements, and potential hazards.

Programming manuals for programmable devices including list of standard programming.

Function, normal operating characteristics, and limiting conditions.

Performance curves, engineering data and tests.

1.8.03 Maintenance Contents. The manuals shall identify the following detailed maintenance and preventative maintenance descriptions:

Type and frequency of preventive maintenance activities required.

Guide to "trouble-shooting", disassembly, repair, and re-assembly.

Alignment, adjusting, and checking.

Servicing and lubrication schedule.

List of lubricants required together with cross-referenced equivalent oils and greases.

Manufacturer's printed operating and maintenance instructions. (This is not to be a generalized catalog of the entire product line.)

List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.

1.8.04 Miscellaneous Details. The manual shall identify the following miscellaneous details:

DWSD Z file number reference to the part, equipment or system.

Prepare and include additional data when the need for such data becomes apparent during instruction of DWSD's personnel.

Additional Requirements for O & M Data required by sections of Specifications.

1.9 SUBMITTAL SCHEDULE.

1.9.01 Equipment Manuals. Ten (10) copies of the O & M Instruction Manual for each piece of equipment shall be submitted to the Engineer with delivery of the equipment.

1.9.02 System O & M Manuals. Ten (10) copies of the system O & M Manuals, bound and indexed shall be submitted to the Engineer 90 days prior to demonstration tests for review and approval. Systems O & M Manuals shall be complete except for field results and refinements added as result of demonstration and phase-over.

Submit ten (10) hard copies and ten (10) electronic copies (CD’s) in

PDF/CAD/WORD Format of the Final Equipment and Systems O & M Manuals, bound and indexed and submitted to the Engineer prior to the Substantial Completion of New Facilities under this Contract.

1.9.03 Training Manuals: Submit two (2) sets of DVD's of the video recording of the training programs for the O&M staff; two sets of DVD's of the overview training video recording for supervisory staff. Copies of approved training manuals shall be provided to all trainees.

Any modifications required after final O & M submission shall be made to the manuals by issuance of addenda in the form of change pages to the manual. The addenda will identify where the new data is to be inserted, what data is to be removed, new index sheets as necessary, DWSD Z file list of shop drawings and submittals. Contractor shall submit information in accordance with Master Specification Section 1080, Project Submittals.

PART 2 - PRODUCTS

2.1 O & M MANUALS.

2.1.01 Binders. The manuals shall be supplied in binders as described in Paragraph 1.4.

2.1.02 Electronic Version. An electronic version of the word-processed portions of the manuals shall also be provided on owner-approved media. The electronic version manuals must be capable of being read, edited and printed. The format and file size requirements of the O & M Manuals will be as approved by the Owner and suitable for use in the Owner's current on-line O&M Software. Format will be provided to the Contractor upon request.

The on-line O & M Manual shall include text, hyper-text, hyper-graphics, photographs, CAD drawings, scanned images, and video clips.

The Contractor shall research all necessary sources of reference materials and prepare original written text for an informative narrative, describing the function of each facility, system, and component. The narrative portion of the on-line O & M Manual shall be enhanced by linking key words and references in the text to pertinent reference information such as manufacturer's manuals, CAD drawings, photographs, and video clips. Linking, through the use of hyper-text and hyper-graphics, shall connect the parts of the manual through a point-and-click user interface. The on-line computerized O & M Manual shall be developed for use in the owners system. The Contractor shall provide all hardware and software necessary to view and maintain the on-line computerized O & M Manual.

The on-line computerized O & M Manual shall include the following sections:

Introduction of the facility to include all new, rehabilitated, and retained facilities.

Facility-specific narratives include system overview, process operation, design criteria, and standard operating procedures.

System-wide narratives shall include system overview and design criteria.

Standard operating procedures shall address start-up, shutdown, normal and abnormal conditions, troubleshooting, monitoring and reporting requirements, laboratory procedures, and emergency response requirements.

2.2 BACK-UP BATTERY. Back-up batteries shall be supplied for all units requiring back-up batteries with sufficient capacity in accordance with manufacturer requirements. Standby and shelf life of the batteries shall be at least 5 years. Only training personnel shall be allowed to replace and maintain back-up batteries.

PART 3 - EXECUTION

Not used

End of Section

SECTION 01170

WARRANTIES AND BONDS

PART I - GENERAL

1.1 SCOPE. This section covers the consolidation and submittal of all specified warranties, bonds, and extended service and maintenance contracts together as one package. This section builds upon Articles 4 and 13 of General Conditions (Exhibit C) of the Agreement.

1.2 SUBMITTALS.

1.2.01 Certifications. Assemble and submit two duplicate sets of all warranties, bonds, and service or maintenance contracts in 3-ring binders. All warranties, bonds, and maintenance or service contracts shall be signed and executed by the responsible contractor, sub-contractor, supplier, and manufacturer.

Submit warranties, bonds, and service/maintenance contracts to Engineer immediately prior to Final Completion. Provide two signed originals of each document.

1.2.02 Format. Prepare duplicate binders. Each binder shall have a detailed Table of Contents neatly typed, following the sequence of the Specifications. Provide complete information for each item as follows:

Product or work item.

Contractor that installed Product or Work Item, with address, telephone, faxes and E-mail address, and the name of responsible principal.

Scope.

Date of beginning of warranty, bond, or service and maintenance contract.

Duration of warranty, bond, or service and maintenance contract.

Provide the following information for use by DWSD personnel:

Proper procedure in case of failure.

Instances that might affect the validity of warranty or bond.
Maintenance or Service Contractor, with address, telephone, faxes and E-mail numbers, and the name of responsible principal.

All warranties, bonds, and service or maintenance contracts shall be on 8-1/2 inch x 11-inch (21.6 x 27.94 cm) paper punched for standard 3-post binder. Fold larger sheets to fit into binders.

Provide commercial quality, 3-post binders, with durable and cleanable plastic covers with maximum post width of two (2) inches (5.08 cm).

Use index tab sheets keyed to the table of contents listing to separate each warranty or bond. Provide full information, using separate typed sheets as necessary.

1.3 WARRANTY. Even if not specifically stated in the Master Specifications, warranties are required for all work. All work specified to be designed or supplied by the Contractor shall be guaranteed to perform as specified. Any service material, equipment required because of the defect, or additional repairs required due to the defect shall be supplied without charge.

All parts of the work or equipment shall be warranted to be free from defects in workmanship, design and materials. In the opinion of the Engineer, if any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Then, the one-year warrantee period shall begin again for that item after repair of equipment and other parts repaired in system. Repairs shall be performed expeditiously as directed by engineer.

Warranty from the manufacturer shall be provided for all major pieces of equipment supplied under this Contract. The manufacturer's warranty period shall be concurrent with the Contractor's running at a minimum of one (1) year from date of Project Substantial Completion, unless otherwise specified. The Engineer reserves the right to request warranties for equipment not classified as major. The Contractor shall still warrant equipment not considered to be "major" in the Contractor's one-year warranty period even though certificates of warranty may not be required. This warranty from the manufacturer shall not relieve the Contractor of his one-year warranty starting at the time of Project Substantial Completion.

1.3.01 Commencement of Warranty Period. The Contractor shall guarantee all parts of the Contract Work for one year from date of “Project Substantial completion”, unless otherwise specified. The Contractor shall remove and replace, or repair in a manner satisfactory to the Engineer, at no cost to the Owner, all parts of the Work, including equipment, which in the opinion of the Engineer prove defective either in material, workmanship or operation. The Contractor shall supply without charge any service, material or equipment required because of such defect. The Contractor shall also guarantee the design and performance of the Work specified, Work repaired or replaced.

If the Owner chooses to occupy and/or use any completed portion of the Work or piece of equipment prior to “Project Substantial Completion”, the Contractor shall provide extended warranty services for that particular portion of Work or piece of equipment for the duration between the day of occupancy or use by the Owner and Project Substantial Completion. Furthermore, one (1) additional year of warranty for such portion of the Work or piece of equipment shall be provided and shall begin on the date of Project Substantial Completion, unless otherwise specified.

The guarantee of operation, materials, workmanship, design, and performance for all equipment and Work replaced or repaired shall be continued for the remainder of the extended warranty period starting after the date of written acceptance of replacement or repair for that particular portion of the Work or piece of equipment and the Project Substantial Completion plus one (1) additional year of warranty following the Project Substantial Completion, unless otherwise specified..

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

Not Used.

End of Section

SECTION 01180

EQUIPMENT, MATERIALS, PARTS AND TOOLS

PART 1 - GENERAL

1.1 SCOPE. This section includes general provisions applicable to the furnishing and installation of material and equipment and delivery of all spare parts, maintenance items, tools and all other required items under this contract. The Contractor shall provide specific equipment, materials, parts, and tools as referenced in other Master Specification Sections. This section identifies general requirements common to other Master Specification Sections. Where provisions of other sections conflict with those in this section, the more stringent of the requirements shall apply.

Unless otherwise provided for in the technical Master Specification Sections, this Section shall govern the packaging, delivery and acceptance of equipment, materials, spare parts, maintenance items and special tools. The Contractor shall refer and adhere to the applicable requirements of other Master Specification Sections within Division 01, General Requirements as applicable.

1.2 GENERAL.

1.2.01 Coordination. Contractor shall coordinate all details of the equipment with other related parts of the work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations in the work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.

1.2.02 Governing Standards. Where standards, codes or specifications are referred to by full name or abbreviation, the reference is to published standards, codes, specifications, tests or recommended methods of trade, industry or governmental organizations. These standards shall include all of the latest amendments and errata applicable at the time the bids are taken.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer’s Qualifications. Unless specifically named in the technical Master Specification Section, a manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.3.02 General Equipment Stipulations. Material and equipment shall conform to all applicable specifications and standards.

Material and equipment shall comply with size, make, type, and quality specified, or as specifically approved in writing by the Engineer.

Design, fabricate, and assemble in accordance with the best engineering and shop practices.

Manufacture like parts of duplicate units to standard size and gauges, to be interchangeable. Two or more items of the same kind shall be identical, by the same manufacturer.

Equipment capacities, sizes, and dimensions shown or specified shall be met unless variations are specifically approved in writing.

Do not use material or equipment for any purpose other than that for which it is designed or specified.

1.4 SUBMITTALS.

1.4.01 Schedule of Submittals. Within 30 days after the Notice to Proceed, the Contractor shall submit a list containing product data and related information for materials and equipment proposed to be furnished in accordance with Master Specification Section 01080, Project Submittals.

Operation and Maintenance Manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals.

Each equipment item shall be certified "factory tested" prior to shipment to the project site. A report of such tests shall be submitted to the Engineer prior to installation of the item. Certified curves are required for all pumps.

1.4.02 Equipment and Material List. The Contractor shall furnish 10 copies of the ‘Equipment Parts List’ and/or ‘Spare Parts Lists’ to the Engineer. These lists shall give Job Title, Contract number and a numerical list, including quantity and description of all equipment and spare parts to be delivered under the Contract. The Contractor shall supplement the list by written notification referencing ‘Equipment Parts List’ and/or ‘Spare Parts List’, with updated information such as expected date of shipment and delivery. Provide not less than 4 weeks notice so that storage identification number can be assigned by the owner. The Contractor shall list approximate number of containers, their dimensions, and gross weights, and furnish copies of actual invoices for each item to substantiate the delivery cost of each item.

Equipment and spare parts are intended solely for the purpose of replacing equipment and worn parts in due course of time to minimize equipment downtime. If equipment or parts prove inherently defective in operation or workmanship during the period of the Contract and the guarantee period, then spares for such items shall also be suspected of like defects and shall also be replaced by the Contractor. Spare parts are for DWSD's use and are not to be used by the Contractor for achieving compliance with the operational requirements of the Contract.

1.4.03 Special Tools. Manufacturers of equipment and machinery shall furnish 2 sets of any special tools (including grease guns or other lubricating devices) required for normal adjustment, operation, maintenance, and disassembly, together with instructions for their use. The Contractor shall preserve and deliver to DWSD these tools and instructions in good order before completion of the Contract. Tools shall be high-grade, smooth, forged, alloy, tool steel. Grease guns shall be lever-type.

Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment. Special tools shall include any type of tool that has been specially made for use on an item of equipment for assembly, disassembly, repair, adjustment or maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices. Special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such special tools until completion of the work, at which time they shall be delivered to DWSD.

A separate set of special tools shall be furnished with each separate item of equipment.

As directed, the Contractor shall furnish and erect one or more neat and substantial steel wall cases with flat key locks and clips or hooks to hold each tool in a convenient arrangement.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Packaging. Packaging shall be in accordance with the best practices of the industry for the shipment and long term storage of parts and equipment. A letter from the manufacturer shall be sent, well before shipment, stating his recommended packaging, for approval. This approval shall not relieve the Contractor of full responsibility for proper packaging. Packaging shall be such that no stresses are imposed on the contents. The container and the filler material shall thoroughly insulate the contents against any reasonable shock or other abuses inherent in shipping, handling, and unloading. Packaging shall protect the contents from external dirt, dust and moisture and damage from other causes. Contents susceptible to the effects of atmospheric corrosion shall be protected by means of sealed plastic wraps with desiccant agents, grease coatings or other proper means.

The outside of each shipping container shall have the following information firmly fastened and legibly posted:

Contract No., Contract Title and Specification, Item Number and Storage

Identification Number.

The words “Equipment”, “Spare parts”, “Special Tools”…, etc.

Complete equipment description if a single unit or item. Provide a list of contents (name equipment) and description and number of each spare item in an attached envelope with bill of lading for multiple contents.

Name and address of manufacturer and other unidentifiable information regarding the contents;

Special instructions as to correct lifting, moving and storage of the container and any other precautionary notes.

The gross shipping weight of the container.

1.5.02 Preparation for Shipment. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of the Contractor.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

1.5.03 Transportation and Handling. Arrange deliveries of products in accordance with construction schedules. Coordinate deliveries to avoid conflict with work and conditions at the site.

Deliver products in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

Immediately on delivery, inspect shipments to assure compliance with requirements of Contract Documents and approved submittals. Verify that products are properly protected and undamaged.

Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

1.5.04 Delivery and Acceptance. Major deliveries shall be scheduled in advance with the Engineer to allow effective inspection at the time of delivery. All deliveries of equipment and spare parts at the site shall be made in the following sequence:

The carrier shall enter the Site and report to the guard on duty stating his business, the nature of his shipment, and desired destination within the Site.

The carrier shall report to the Contractor’s Superintendent on duty at the Site. Thereafter, the packages shall be delivered, with the Engineer present before unloading, at the site.

The Contractor shall aide the Engineer in his inspection of the container contents and correctly repack the container after inspection according to the instructions of the manufacturer for long term storage.

Equipment and spare parts will only be accepted by the Engineer if:

The Container has no visible signs of extensive damage, mutilation or contamination.

Contents are all present, packed and labeled correctly, are undamaged and properly prepared for long term storage.

Components are packaged to allow ready access for required “in storage” maintenance procedures as noted in the manufacturer’s storage instructions.

Manufacturer’s long term storage instructions and spare units installation of the procedures accompany or have preceded the shipment. This requirement may be waived by the Engineer if no particular care or special instructions are deemed necessary or if such information already appears in the previously approved submittals.

1.5.05 Storage and Protection. The Contractor shall furnish a covered, weather-protected storage structure providing a clean, dry, non-corrosive environment to store items delivered to the sites. Locate on-site storage facilities in areas approved by the Engineer. When adequate storage space is unavailable on the site, the Contractor shall make its own arrangements for storing equipment off-site as required at his own cost. Temporary indoor/outdoor storage may be available to the Contractor at the following DWSD facilities: Central Services Facility (CSF), Water Works Park WTP, and Springwells WTP. The Contractor shall obtain approval in writing from DWSD Facility Manager prior to entering site.

The storage structure shall be properly protected, guarded, and the equipment shall be stored as specified. Storage of equipment shall be in strict accordance with the manufacturer’s "storage instructions" storage procedures include but are not limited to connection of heaters, placing of storage lubricants in equipment, etc. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project. Equipment and materials not properly stored will not be included in a payment estimate.

All materials and equipment shall be handled and stored by the Contractor before, during, and after shipment in a manner to prevent warping, twisting, bending, breaking, chipping, rusting, theft, or damage of any kind to the material or equipment.

Store products with seals and labels intact and legible. Store products subject to damage by the elements in weather-tight enclosures. Maintain temperature and humidity within the ranges required by manufacturer's instructions.

Store fabricated products above the ground, on blocking or skids to prevent soiling or staining. Cover products that are subject to deterioration with impervious sheet coverings, and provide adequate ventilation to avoid condensation.

Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60 F (15.5 C). Equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.

Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.

Cement and sand shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural and miscellaneous steel and reinforcing steel shall be stored off the ground in a manner to prevent accumulations of dirt, grease, standing water and to minimize rusting. Beams shall be stored with the webs vertical. Pre-cast concrete beams shall be handled and stored in a manner to prevent accumulation of dirt, standing water, staining, chipping, or cracking. Brick, block, and similar masonry products shall be handled and stored in a manner to minimize breakage, chipping, cracking, and spalling.

Contractor shall arrange storage in a manner to provide easy access for inspection and make periodic inspections of stored products to assure that products are maintained under specified conditions, free from damage or deterioration. Contractor shall provide substantial coverings as necessary to protect installed products from traffic damage and subsequent construction operations. Contractor shall remove coverings when no longer needed.

The Contractor shall be responsible for all material, equipment, and supplies sold and delivered to DWSD under this Contract until final inspection of the work and acceptance by DWSD. In the event any materials, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the

Contractor shall replace same without additional cost to DWSD.

All materials which, in the opinion of the Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the site. The Contractor shall receive no compensation for the damaged material or its removal.

Should the Contractor fail to take proper action on storage and handling of equipment supplied under this Contract, within 7 days after written notice to do so has been given, DWSD retains the right to correct all deficiencies identified in written notice and deduct the cost associated with these corrections from the Contract. These costs may be comprised of expenditures for labor, equipment usage, administrative, clerical, engineering, and any other costs associated with making the necessary corrections.

After installation, all equipment shall be adequately protected from further construction activities.

Coated surfaces shall be protected from impact, abrasion, discoloration and other damage. All coated surfaces damaged shall be recoated.

Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

1.5.06 Storage and Handling. Because of the long period allowed for construction, special attention shall be given to the storage and handling of equipment on site. As a minimum, the procedure outlined below shall be followed:

> The Contractor shall furnish details of storage facilities and instructions for storage for approval prior to shipment.
>
> Equipment shall not be shipped until accepted by the Engineer. The intent of this requirement is to reduce on-site storage time prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer. Equipment shipped to the site shall be stored in accordance with the requirements of this section. Operation and maintenance data as described in Master Specification Section 01160, Training and Operations & Maintenance Manuals shall be submitted to the Engineer for review prior to shipment of equipment.
>
> All equipment having moving parts such as gears, electric motors, etc., and/or instruments shall be stored in a temperature and humidity controlled building accepted by the Engineer, until such time as the equipment is to be installed. All equipment shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer.

Manufacturer's storage instructions shall be carefully followed and a written record of this kept by the Contractor.

Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding." Upon installation of the equipment, the Contractor shall start the equipment once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. Mechanical equipment to be used in the work when stored for longer than ninety (90) days shall have the bearings cleaned, flushed and lubricated prior to testing and startup.

Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certification shall be deemed to mean that the equipment is judged to be in a condition equal to that of equipment that has been shipped installed, tested, and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor’s expense.

1.6 WARRANTY. Submit warranties from manufacturer and for other construction as specified in Master Specifications Section 01170, Warranties and Bonds and related technical Sections.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS.

2.1.01 Elevation. The elevation of Detroit is approximately 580 feet (176.8 m) above mean sea level. All equipment furnished for this project shall be designed to meet stipulated conditions and to operate satisfactorily at this general elevation.

2.2 WORKMANSHIP AND ACCEPTANCE OF MATERIALS AND EQUIPMENT. Equipment Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests, and shall be identified properly by part name, manufacturer, and year manufactured.

Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch (6.4 mm) thick.

Only new materials and equipment shall be incorporated in the work. All materials and equipment furnished by the Contractor shall be subject to the inspection and acceptance of the Engineer. No material shall be delivered to the work if the Engineer objects.

The Contractor shall furnish facilities and labor for handling and inspection of all materials and equipment. When requested by the Engineer, the Contractor shall submit samples of materials for such special tests as may be necessary to demonstrate conformance to the specifications. Such samples shall be furnished, stored, packed, and shipped as directed at the Contractor's expense. Except as otherwise noted, DWSD will make arrangements for and pay for these tests.

The Contractor shall submit data and samples sufficiently early to permit consideration and acceptance before materials are necessary for incorporating in the work. Any delay of acceptance resulting from the Contractor’s failure to submit samples or data promptly shall not be used as a basis of claim against DWSD.

In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes, and surfaces, the Contractor shall provide such samples of workmanship or finish as may be required.

The materials and equipment used on the work shall correspond to the approved samples or other data.

The Contractor shall submit ample evidence that each and every part of the materials, machinery, and equipment to be furnished are of a reliable make and of a type that has been in successful operation within the continental United States. An installation of any experimental or untried type of apparatus, material, or machinery shall not be allowed by the Engineer.

The equipment specified herein shall be carefully designed and installed to ensure that all required functions shall perform adequately within the specified degree of precision. Each unit shall operate with each of the other parts of the equipment to provide a completely integrated system that shall operate to the satisfaction of the Engineer.

All equipment, machinery, parts, and assemblies thereof, entering into the work shall be tested as specified. Unless waived in writing by the Engineer, all field and operating tests shall be made in the presence of the Engineer or its authorized representative. When such a waiver is issued, sworn statements in duplicate of the tests made and the results thereof shall be furnished to the Engineer by the Contractor or manufacturer. Costs of all tests and trials specified shall be borne by the Contractor, unless noted otherwise, and shall be included in the contract price.

The Contractor shall submit copies of welding procedures for all welding. Welders and welding operators shall be in accordance with the qualification requirements of the AWS Code. Welders and welding operators for stainless steel shall pass qualification tests using stainless steel filler metal and procedures developed for stainless steel. Procedures, welder, and operator qualifications shall be certified by an independent testing laboratory retained and paid by the Contractor.

The Contractor shall not start fabrication of the work until the Engineer receives written acceptance of the proof of welding procedures from the Designer for each type of weld.

The Contractor shall submit copies of mill certificates for each type of rolled steel and as required in the specifications. The Contractor shall not start fabrication of the work until the Engineer receives written acceptance of all mill certificates from the Contractor.

2.3 ACCESSORIES.

2.3.01 Safety Guards. All equipment shall be provided with removable safety guards around rotating, reciprocating, or other moving parts.

The safety guards shall conform to MIOSHA requirements.

Safety guards shall be constructed of 12 USS Gage (2.7 mm) or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (1.3 cm) mesh galvanized expanded metal.

All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.3.02 EQUIPMENT BASES. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (15.2 cm) high. Cast iron or welded steel adjust space baseplates shall be provided for pumps, compressors, and other equipment. Each unit and it’s drive assembly shall be supported on a single baseplate of neat design.

All metal surfaces in contact with concrete shall be coated with 12 to 20 dry mils (0.30 - 0.51 mm) of bitumastic paint.

Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout, unless indicated otherwise.

2.3.03 Anchor Bolts. Anchor bolts shall be provided in accordance with Master Specification Sections 05550, Anchor Bolts and Expansion Bolts. Equipment suppliers shall furnish suitable anchor bolts for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

The Contractor shall furnish all other necessary bolts, anchor bolts, nuts, washers, plates, and bolt sleeves.

Anchor bolts shall be at least 3/4 inch (1.9 cm) in diameter unless otherwise specified.

Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches (3.8 cm) of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

2.3.04 Electric Motors. Unless otherwise specified or permitted, all electric motors furnished and installed by the Contractor shall conform to Master Specification Section 16220, General Purpose Induction Motors-Procurement.

2.3.05 Shop Painting. All steel and iron surfaces shall be protected by suitable coatings applied in the shop in accordance with Master Specification Section 09900, Painting. Surfaces, which will be inaccessible after assembly, shall be protected for the life of the equipment.

Coatings shall be suitable for the environment where the equipment is installed. The manufacturer at the factory shall apply a prime and one finish coat.

The second finish coat shall be applied in the field. Shop applied coatings shall be compatible with field applied coatings.

Paint equipment according to DWSD color code. Color of equipment not listed will be as selected by the Engineer or as noted in the detail Specifications.

2.3.06 Spare Parts. The Contractor shall furnish complete spare parts for equipment. For each spare part, the Contractor shall provide the part name, manufacturer, year manufactured, address and telephone number.

Product data submitted for all items of equipment shall include complete current published parts information. Information shall clearly show the manufacturer's recommended spare parts and should be supplied as a minimum by the Contractor.

2.3.07 Bearings. All bearings, including those provided in gearboxes, drives, and reducers, except those furnished as an integral part of electric motors, shall conform to the requirements specified herein.

All bearings shall be anti-friction type constructed completely of stainless steel material specially selected for the service required. The bearings shall have a B-10 life, without adjustment factors, of 40,000 hours accept as otherwise defined in technical Master Specification Sections.

All bearings shall be equipped with double seals and cap to completely prevent the intrusion of dirt, dust, water, sludge, chemical, etc., from entering the bearing. The seals shall be effective in preventing the entrance of water from a high pressure hose.

All bearings shall be oil or grease lubricated. The use of permanently sealed, grease lubricated bearings will not be acceptable unless specifically called for in the detailed specification for equipment items. A dipstick or a sight glass arranged to permit visual inspection of lubricant level shall be provided on each unit.

Bearing selection shall be based upon the most severe duty of the unit while operating continuously for 24 hours a day, 7 days per week, with an appropriately selected service factor based on the manufacturers published data.

2.3.08 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Engineer. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

During start-up and throughout the Maintenance Period, the Contractor shall properly lubricate all equipment furnished under this Contract.

2.3.9 Grease, Oil, and Fuel. All grease, oil, and fuel shall be furnished with the respective equipment.

The Contractor shall be responsible for changing the oil in all drives of mechanical equipment after initial break-in of the equipment, which shall be no greater than 30 days.

During testing and prior to acceptance, the Contractor shall furnish all lubricants necessary for the proper lubrication of all equipment furnished under this Contract.

2.3.10 Concrete Inserts. Concrete inserts for hangers shall be designed to support safely, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be galvanized, unless otherwise specified.

2.3.11 Sleeves. Unless otherwise indicated on the drawings or specified, openings for the passage of pipes through floors and walls shall be formed of sleeves of standard-weight, galvanized-steel pipe. The sleeves shall be of ample diameter to pass the pipe and its insulation, if any, and to permit such expansion as may occur. Sleeves shall be of sufficient length to be flush at the walls and the bottom of the slabs and to project 1-inch (2.54 cm) above the finished floor surface. Threaded nipples shall not be used as sleeves.

Sleeves in exterior walls below ground or in walls to have liquids on one or both sides shall have a 2-inch (5.1 cm) annular fin of 1/8-inch (3.2 mm) plate welded with a continuous weld completely around the sleeve at about mid-length. Sleeves shall be galvanized after the fins are attached.

All sleeves shall be set accurately before the concrete is placed, or shall be built-in accurately as the masonry is being built.

2.3.12 Nameplates. With the exceptions mentioned below, each piece of equipment shall be provided with a substantial nameplate of non-corrodible metal, securely fastened in place and clearly and permanently inscribed with the following: manufacturer's name, model, or type designation, serial number, principal rated capacities, electrical, or other power characteristics, and similar information as appropriate. Equipment tag numbers shall be assigned by DWSD.

This requirement shall not apply to standard, manually operated hydrants or to gate, globe, check, and plug valves smaller than 6" in diameter.

Each process valve shall be provided with a substantial tag of non-corrodible metal securely fastened in place and inscribed with an identification number in conformance with the Valve Identification Schedule.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS FOR INSTALLATION. The equipment installation details shall suit the existing and furnished equipment and are subject to Engineer acceptance.

Any changes or revisions made necessary by the type and dimensions of the equipment furnished shall be made at the expense of the Contractor. Contractor shall furnish detailed drawings showing such changes or revision for the acceptance of the Engineer.

All equipment shall be installed according to the submitted manufacturer's instructions. The Contractor shall maintain a complete set of instructions on the site until the completion of all work.

Handle, install, connect, clean, condition, and adjust products in strict accord with such instructions and in conformity with specified requirements. Site conditions or specified requirements conflicting with manufacturer's instructions must be brought to the Engineer 's attention.

Perform work according to manufacturer's instructions. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by Contract Documents.

3.2 INSTALLATION OF EQUIPMENT. Provide competent manufacturers' representatives for all equipment to supervise the installation, adjustment, and testing of the equipment and to instruct DWSD's operating personnel on operation and maintenance.

A certificate from the manufacturer shall be submitted before substantial completion stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

The Contractor shall furnish the service of competent manufacturers' representatives for Contractor furnished equipment, when evident malfunction or over-heating makes such services necessary or as determined by the Engineer. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.

Special care shall be taken to ensure proper alignment of all equipment. Units shall be carefully aligned on their foundations by qualified millwrights after their sole or base plates have been shimmed to true alignment at the anchor bolts. The anchor bolts shall be set in place and the nuts tightened against the shims. After the manufacturer has approved the foundation alignment, the bedplates or wing feet of the equipment shall be securely bolted in place. The alignment of equipment shall be further checked after securing to the foundations, and after confirmation of all alignments, the sole or base plates shall be finally grouted in place. The Contractor shall be responsible for the exact alignment of equipment with associated piping, and under no circumstances, will "pipe springing" be allowed.

All wedges, shims, filling pieces, keys, packing, grout, or other materials necessary to properly align, level, and secure apparatus in place shall be furnished by the Contractor. All parts intended to be plumb or level must be proven exactly so. Any grinding necessary to bring parts to proper alignment after erection shall be done at the expense of the Contractor.

The Contractor shall furnish the necessary materials and construct suitable concrete foundations or pads for all equipment installed, even though such foundations or pads may not be indicated on the drawings. The tops of foundations shall be at such elevations as will permit grouting.

In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1-inch (2.5 cm) for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and so as to be as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-shrinking grout per Master Specification Section 03600, Grout.

Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamber around the top edge of the finished foundation.

Where such procedure is impracticable, the Engineer shall approve the method of placing grout. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, if necessary, given burlap-rubbed finish and painted with at least two coats of an acceptable paint.

Before piping or electrical connections are made, verify that equipment is leveled and aligned on bases and foundations per manufacturer's instructions and recommended tolerances. Recheck before start-up. Assure that thrust is balanced, that shaft can be freely rotated by hand and that motor is quiet in operation. After all adjustments are completed, recheck alignment and adjust as necessary. Piping should not place stress on the equipment flanges. Support piping as necessary to meet this requirement, bolt tightly and grout. Final checking and adjustment shall be performed by the manufacturer's representative, a qualified millwright, or machinist. Proof of such qualification shall be provided to the Engineer.

Each pumping unit shall be leveled, plumbed, aligned and wedged into position with connecting piping. Installation procedures shall be as recommended by the pump manufacturer and as required herein.

The pump base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. After final alignment and bolting, pump connections shall be tested for applied stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to ensure that piping stresses are not transmitted to the pump flanges.

Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results. When so specified, or when employees of Contractor or its Subcontractors are not qualified, such personnel shall be field representatives of the manufacturer of the equipment or materials being installed.

Qualified field representatives shall be provided by each equipment manufacturer as required to perform all manufacturer's field services called for in the Specifications. Manufacturers' field representatives shall observe, instruct, guide, and direct Contractor's erection or installation procedures, or perform an installation check, as required. Each field representative shall revisit the site as often as necessary to attain installation satisfactory to Engineer.

All equipment installed under this Contract shall be placed into successful operation according to the written instructions of the manufacturer or the instructions of the manufacturer's field representative. All required adjustments, tests, operation checks, and other startup activities shall be provided.

3.3 PROTECTION AGAINST ELECTROLYSIS. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers; or other acceptable materials.

3.4 TESTS AND TEST REPORTS. When used in the Contract Documents, "Factory/Fabricating Shop Performance, Evaluation, Certification, and/or Acceptance Tests and Test Reports" shall be considered to mean the corresponding manufacturer's, fabricator's and/or other builder's official tests and tests reports of same. Included in these test reports are appropriate substantiating documentation/data detailing the correct and complete manufacture, fabrication, and "shop performance" (to greatest extent normally practicable) of the particular material, equipment, system and/or facilities proposed for eventual delivery. These are subdivided into three (3) significant tests and test report types:

Certification Tests and Test Reports

Factory Tests and Test Reports

Shop Performance/Evaluation Tests and Test Reports

3.4.01 Certification Tests and Test Reports. Standard specifications, code references, etc. for minimum quality and workmanship levels are indicated in the Contract Documents. Contractor shall compile statements, certificates, other substantiating reporting data, and tests or “Construction Test Reports” conducted on previously manufactured materials or equipment identical to that proposed for use.

As a minimum, all Certification Test Reports shall contain an official analysis of sufficient material composition or show evidence of meeting or exceeding the specified material standard(s) referenced, i.e., ASTM, ASME, etc. All reports shall also indicate from whom the material was/will be purchased.

Unless otherwise waived in writing by the Engineer, separate Certification Test Reports shall be submitted on all materials incorporated into the Work of this Contract. Such reports shall be delivered to the Engineer for review as part of the first submission of the technical submittal corresponding to such material or equipment (see Master Specification Section 01080, Project Submittals for compilation and composition requirements for all project submittals).

The Contractor shall pay all costs of certification tests and test reports.

3.4.02 Factory Tests and Test Reports. Additional tests and reports performed on material or equipment by the manufacturer or fabricator to ascertain quality or workmanship are referred to herein as "Factory Tests and Test Reports".

Prior to the delivery of any Factory Test Report, the Contractor shall first submit for review and approval, a detailed description of the proposed testing including reporting procedure and criteria. Such descriptions shall be delivered as part of the first submission of the technical submittal.

Materials and equipment used in the performance of the Work under this Contract are subject to inspection and testing at the point of manufacture or fabrication. If Work is to be inspected on behalf of DWSD during its fabrication or manufacture away from the construction site, the Contractor shall propose in writing to the Engineer at least 30 days in advance the place and time where such test of fabrication or manufacture is to be done. The Engineer shall approve or disapprove the date and notify the Contractor so that the necessary arrangements for the particular factory inspection tests can be made.

Should the Engineer deem the prescribed factory inspection tests of such importance to require the services of an independent testing laboratory or the witnessing by 4 of DWSD’s representatives, the Contractor will be duly notified. Travel costs incurred to the prescribed inspection tests shall be borne by DWSD and the Engineer respectively for their employees. In the event that the factory tests are not successful and must be re-accomplished, the travel costs for additional trips will be reimbursed to the Engineer and DWSD by the Contractor. Costs shall include travel, lodging, meals and all other reasonable travel-related expenses required for such individuals' observations and round-trip travels.

Upon completion of the factory inspection tests and immediately following manufacture or fabrication, the Contractor shall compile a complete Factory Test Report per the approved format above. All such reports shall be delivered to the Engineer for review as part of the technical submittal corresponding to such tested material or equipment (see Master Specification Section 01080, Project Submittals for details on execution and submission requirements for all project submittals).

3.4.03 Shop Performance/Evaluation Tests and Tests Reports. Material and equipment used in the performance of the Work of this Contract are also subject to the evaluation and testing after the complete, full-scale assembly into major equipment and/or systems. Shop Performance/Evaluation Tests, i.e. tests of simulated Startup, steady state, variable loading, and other normal operating conditions, for such assembled equipment/systems shall be accomplished in strict accordance with the standard testing practices specified or otherwise accepted by the Engineer.

Prior to the delivery of any Shop Performance/Evaluation Test Report, the Contractor shall submit for review, a detailed description of the proposed performance/evaluation tests, including anticipated reporting procedures, data reduction, and criteria used. Where appropriate, such descriptions shall be delivered to the Engineer for review as part of a first or subsequent submission of the technical submittal.

Should such performance/evaluation tests be accomplished away from the construction site, the Contractor shall propose in writing to the Engineer at least 30 days in advance the place and time where such test of fabrication or manufacture is to be done. The Engineer shall approve or disapprove the date and notify the Contractor so that the necessary arrangements for the tests can be made.

Travel costs incurred to the prescribed performance/evaluation tests unless otherwise specified in the detailed equipment specifications shall be borne by DWSD and the Engineer respectively for their employees. In the event that the tests are not successful and must be re-accomplished, the travel costs for additional trips will be reimbursed to the Engineer and DWSD by the Contractor. Costs shall include travel, lodging, meals and all other reasonable travel-related expenses required for such individuals' observations and round-trip travels.

The requirements above pertaining to Factory Tests and Test Reports, shall be incorporated herein for shop Performance/Evaluation Tests and Test Reports. Unless factory tests are coincident with shop performance tests and vice versa for the same material or equipment, a minimum of 15 days shall be scheduled between such multiple equipment tests, where extended travel is required.

3.4.04 Cost of Performance Shop Tests. The Contractor shall conduct shop performance full-scale tests at its expense on all equipment as specified. Each piece of equipment shall be tested completely assembled and the shop test performed by the equipment manufacturer until successful tests are achieved.
Travel costs incurred to the prescribed performance tests unless otherwise specified in the detailed equipment specifications shall be borne by DWSD and the Engineer respectively for their employees. In the event that the tests are not successful and must be re-accomplished, the travel costs for additional trips will be reimbursed to the Engineer and DWSD by the Contractor. Costs shall include travel, lodging, meals and all other reasonable travel-related expenses required for such individuals' observations and round-trip travels.

3.5 FIELD TESTING. Field-testing shall be conducted when called for in the technical specification sections and on all completed systems in general.

After completion of the installation, the Contractor, in the presence of the Engineer, under actual operating conditions, shall test the system. Tests shall be performed according to manufacturer's recommendations.

The Contractor shall include with its bid the services of the equipment manufacturer's field service technician for a period necessary to complete the work to the satisfaction of the Engineer and DWSD. This service shall be for the purposes of checkout, initial start-up, certification, and instruction of plant personnel.

The equipment supplier shall furnish gauges, instruments, test equipment and personnel required for testing. Adjust equipment to perform with the least possible noise and vibration consistent with its duty. Allowable vibration amplitude shall be 2.0 mils (0.05 mm) maximum for blowers or any 3600 rpm machinery.

The Contractor shall arrange for a qualified service representative to perform the initial equipment check-out. The Contractor shall make any adjustment/corrections to the equipment installation as required or recommended by the qualified service representative.

After the Engineer has reviewed and accepted the manufacturer’s representatives report, the Contractor shall make arrangements for the field acceptance tests. Qualified manufacturer’s representatives shall be present during the acceptance tests.

The purpose of the acceptance tests is to demonstrate the equipment’s ability to operate without excessive noise, vibration, overheating, or excessive maintenance and to deliver the rated capacity or service under specified conditions. Field conditions shall be the equivalent of anticipated service conditions and accepted by the Engineer prior to testing.

Field tests shall be suited to the equipment being tested. Refer to the appropriate technical Master Specification Section for a list of the items that should be field tested for each type of equipment.

The Contractor shall provide all necessary supervision and labor, materials, tools, test instruments, or other equipment or services required to test, adjust, set, and calibrate the equipment.

The Contractor shall correct or replace promptly defects or defective equipment revealed by or noted during the tests and repeat tests until results acceptable to the Engineer are obtained at no expense to the Owner.

If the Contractor is unable to demonstrate to the satisfaction of the Engineer that the equipment item satisfactorily performs the service required and will operate free from excessive noise, vibration heating or maintenance, the equipment item will be rejected. The Contractor shall then remove and replace the item and repeat all inspection and testing at no cost to the Owner.

All costs associated with the field testing, including providing necessary fluids to pump, shall be paid for by the Contractor. Each field test shall be of suitable duration to demonstrate the units ability to operate satisfactorily over its entire specified operating range.

The Contractor will supply a certificate of installation stating that the equipment is properly installed and adjusted to operate as designed.

Prior to any testing, the Contractor shall submit the test procedures and data sheets for Engineer's review and approval.

A written report covering the technician's findings and installation approval shall be submitted to the Engineer covering all inspections and outlining in detail any deficiencies noted.

Equipment and System Function and Performance Tests shall be conducted by the Equipment Supplier in the presence of the Engineer.

3.6 EQUIPMENT OPERATION TEST. The Engineer will accept an equipment system as finally completed when the system operates for 30 consecutive days as specified without breakdown. In the event of a breakdown or unsatisfactory performance the Contractor shall make all necessary repairs and a new 30 consecutive day period shall commence. All repairs costs during the initial and follow-on 30 day periods shall be borne by the Contractor.

3.7 ACCEPTANCE OF INSTALLATION. The Engineer may accept an equipment system installation as ready for Substantial Completion of New Facilities when:

The Engineer has accepted all factory tests and all other component testing.

The Engineer has accepted all performance shop tests.

All components of the system are fully installed and tested, including without limitation hydrostatic tests, leak tests, continuity tests, insulation resistance tests, phase rotation tests, bump tests, stroke testing, calibration, adjustment for proper operation, and all other component tests as appropriate.

Field start-up activities have been completed and approved by the Engineer.

The certificates in this section have been submitted.

All equipment has met the performance requirements.

The Engineer has accepted integrated system tests and adjustments performed by the Contractor to demonstrate that the system as a whole functions reliably and meets the performance requirements, in manual and automatic modes, without failure, fault, or defect of any component or of the system as a whole.

The demonstration test has been successfully completed in accordance with the requirements herein.

The Engineer has accepted the O&M Manuals.

All required DWSD personnel have been trained.

All other Contract requirements for Substantial Completion have been satisfied.

3.8 BUILDING OPENINGS FOR ADMISSION OF EQUIPMENT. The Contractor, upon review by Owner, shall provide special break-out openings in the all buildings and structures to move in or remove new and existing equipment. Openings shall be constructed free of obstructions and As-Built drawings shall document the location and purpose of opening.

3.9 SERVICES OF MANUFACTURER'S REPRESENTATIVE. The Contractor shall arrange and pay for a qualified service representative from each company manufacturing or supplying certain equipment as listed in this Section (or in the respective technical Master Specification Sections) to perform the duties herein described. The extent of services required shall be as specified in each equipment section, but in no case shall be less than one 8-hour day.

After installation of the listed equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the representative shall inspect, operate, test, and adjust the equipment. The inspection shall include, but not be limited to, the following points as applicable:

Soundness (without cracked or otherwise damaged parts).

Completeness in all details, as specified.

Correctness of setting, alignment, and relative arrangement of various parts.

Adequacy and correctness of packing, sealing, and lubricants.

The operation, testing, and adjustment shall be as required to prove that the equipment is left in proper condition for satisfactory operation under the conditions specified.

On completion of its work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer a complete, signed report of the result of its inspection, operation, adjustments and tests. The report shall include detailed descriptions of the points inspected, tests and adjustment made, quantitative results obtained, if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

After the Engineer has reviewed the reports from the manufacturer's representatives, the Contractor shall make arrangements to have the manufacturer's representatives present when the field acceptance tests are made.

The Contractor shall arrange for the service of qualified service representatives from the companies manufacturing or supplying all equipment under the Contractor’s contract.

End of Section

SECTION 01190

CONTRACT CLOSEOUT AND CLEANING

PART 1 - GENERAL

1.1 SCOPE. This section covers contract closeout procedures and both ongoing and final cleaning of the Work. This section builds upon General Conditions (Exhibit C) of the Agreement and includes administrative provisions for Substantial Completion and for Final Acceptance.

1.2 GENERAL.

1.2.01 Coordination. Refer to other Master Specification Sections in Division 1 for coordination.

1.3 CLEANING.

1.3.01 Site Cleaning Requirements. Maintain project site free of waste materials, debris, and rubbish and in a clean and orderly condition on a weekly basis throughout duration of Work. If the premises and job site are not maintained properly, the Owner may have accumulations of waste materials or trash removed and charged the Contractor for those costs.

1.3.02 Street Cleaning Requirements. All public or private property streets or roads, occupied or used by the Contractor shall be kept in a neat and orderly condition at all times. When directed by the Engineer, but not less than weekly, the Contractor shall sweep the streets with a sweeper. This requirement shall apply to any streets or roads in the vicinity of the Work which are affected by the Contractor's construction or hauling operations, and as well as to streets or roads in which the Work is located. Should the Contractor neglect his duties in maintaining the proper street or road cleanliness, the City has the authority to take necessary steps to perform such cleaning and will charge the Contractor for those costs.

1.4 RESTORATION REQUIREMENTS. At the completion of his Work, the Contractor shall remove all temporary construction buildings, equipment, tools, surplus or waste materials and rubbish of any sort from public or private premises temporarily occupied in the vicinity of the Work.

Complete all final cleaning and restoration work prior to final inspection, cleaning and disposal operations to comply with codes, ordinances, regulations and environmental protection laws.

Contractor shall restore all property occupied or affected by operations to its original condition as nearly as practicable. Lawn areas may be seeded, unless otherwise noted. Paved areas shall be restored in accordance with Master Specification Sections 02730 through 02900, compatible with the surrounding area, using like materials and workmanship. The final condition of the premises shall be subject to the approval of the Engineer.

1.5 REINSPECTION FEES. Should status of completion of Work require more than one re-inspection by Engineer due to failure of Work to comply with Contractor's claims on initial inspection, DWSD will deduct from final payment to Contractor the amount of Engineer's compensation for additional re-inspection services.

1.6 SUBSTANTIAL COMPLETION. Contract shall follow paragraph 9.7 of the General Conditions (Exhibit C) of the Agreement and other Contract Documents when Contractor considers the Work or designated portion of Work to be substantially complete.

1.7 FINAL COMPLETION. Upon receiving the certificate of substantial completion or partial completion from Engineer, Work shall be complete once all close-out submittals are received and approved by Engineer. When Contractor considers Work, or designated period of Work, is complete, submit written certification indicating that:

Contract Documents have been reviewed.

Work has been completed and inspected for compliance with Contract Documents.

Deficiencies listed with Certificates of Substantial Completion have been corrected

All equipment and systems have been fully tested and are operational.

All required shop drawings, catalog cuts, maintenance manuals, instruction manuals, test reports, samples, operational manuals and other submittals have been submitted and approved by the Engineer.

The Engineer will conduct final inspection of the Work. Should Engineer's final inspection reveal Work incomplete, the Engineer shall promptly notify Contractor in writing listing observed deficiencies. Contractor shall remedy deficiencies and send a second certification of Final Completion.

The Engineer will reinspect the Work. When Engineer finds Work is complete, closeout submittals shall be submitted.

1.8 CLOSE-OUT SUBMITTALS. Contract shall submit the following close-out submittal items:

Certificate of Occupancy.

All required Certificates of Inspection.

Record Documents.

Operation and Maintenance Data.

Warranties and required Bonds.

Spare Parts and Maintenance Materials (At Final Completion only).

Keys and keying schedule.

Consent of Surety to Final Payment.

As-built documents for all items of construction on electronic format.

1.9 APPLICATION FOR FINAL PAYMENT. Contractor shall submit application for final payment in accordance with provisions of General Conditions.

PART 2 - PRODUCTS

2.1 CLEANING. Use only those cleaning materials that will not create hazards to health or property and that will not damage surfaces. Use only those cleaning materials and methods recommended by manufacturer of the surface materials to be cleaned and by cleaning material manufacturer.

PART 3 - EXECUTION

3.1 CLEANING REQUIREMENTS. The Contractor shall be responsible for the general maintenance of the premises and the job site and for the coordination of the clean-up work of all trades.

Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces, prior to enclosing the space.

Contractor’s equipment, temporary building, and excess materials shall be promptly removed, as they become no longer needed for prosecution of the Work.

3.1.02 Weekly Cleaning Requirements. Perform weekly cleaning to keep the Work, the site and adjacent properties free from accumulations of waste materials, rubbish, and windblown debris resulting from construction operations. Dispose off all materials collected through the cleaning process.

Each week, perform interior cleaning. Clean interior and exterior exposed-to-view surfaces. Remove temporary protection and labels not required to remain. Clean finishes free of dust, stains, films and other foreign substances. Clean transparent and glossy materials to a polished condition; remove foreign substances. Polish reflective surface to clear surfaces. Clean light fixtures and lamps. Vacuum clean carpet and similar soft surfaces. Clean resilient and hard-surface floor as specified. Clean surfaces of equipment; remove excess lubrication. Clean plumbing fixtures, to a sanitary condition.

Provide on-site containers for the collection of waste materials, debris and rubbish. Collect and remove waste materials, debris and rubbish from site at least weekly and dispose of off-site as containers become full.

3.1.03 Daily Cleaning Requirements. Daily, clean locker rooms and lavatory areas. Remove waste from receptacles.

3.1.04 Street Cleaning. When directed by the Engineer, but not less than weekly, the Contractor shall sweep the streets with a sweeper. Waste materials, rubbish and debris shall not be allowed to accumulate. The sweeper shall have a main broom, conveyor, sprinkler system and storage hopper.

3.1.05 Dust Control. Broom and vacuum clean interior areas of the building just prior to the start of painting and finish Work. Continue cleaning these areas to eliminate dust and maintain in satisfactory condition for painting and finishing as directed by the Engineer.

Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.2 DAMAGED PROPERTY. Restore or replace, when and as directed, any public or private property damaged by Work, equipment, or employees, to a condition at least equal to that existing immediately prior to beginning of operations and to the satisfaction of the owner of the property. To this end, the Contractor shall perform, as required, all necessary highways or driveway, walks and landscaping work. Suitable materials, equipment and methods shall be used for such restoration. The restoration of existing property or structures shall be done as promptly as practicable as work progresses and shall not be left until the end of the Contract period.

3.3 FINAL CLEANING. Clean the entire Work site as specified in Article 3.1 above and as required below. Employ skilled workmen for final cleaning.

Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces.

Clean out all floor drains in all Work areas to allow full drainage.

Clean permanent filters of ventilating equipment and replace disposable filters when units have been operated during construction; in addition, clean ducts, blowers, and coils when units have been operated without filters during construction.

Remove waste, foreign matter, and debris from roofs, gutters, area ways, and drainage systems.

Remove wastes, debris, and surplus materials from site. Clean grounds; remove stains, spills, and foreign substances from paved areas and sweep clean. Rake clean other exterior surfaces.

Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes, structures, as the result of Work done under this Contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the Work, and the ditches, channels, drains, pipes, structures and Work, etc., shall, upon completion of the Work, be left in a clean and neat condition.

Prior to final completion, or Owner occupancy, conduct an inspection of sight-exposed interior and exterior surfaces and all Work areas to verify that the entire Work is clean.

The Contractor shall thoroughly clean all materials and equipment installed by him and his subcontractors and on completion of the work shall deliver it undamaged and in fresh and new-appearing condition. All mechanical equipment shall be left fully charged with lubricant and ready for operation.

Maintain cleaning until Final Completion.

End of Section

SECTION 01200

EQUIPMENT RECORDS

PART 1 – GENERAL

1.1 SCOPE

This section covers the consolidation and submittal of technical documentation for each piece of equipment specified in the Divisions 2 through 17 technical specification sections under this Contract for input this information into Owner's computerized maintenance management and financial systems.

The Contractor shall furnish all labor, equipment, materials, and incidentals required to deliver technical documentation for the Work to the Owner in accordance with the requirements of this section.

1.2 RELATED REQUIREMENTS.

A. Section 01010, Administrative Provisions
B. Section 01020, Documentation Standards
C. Section 01030, Summary of Work
D. Section 01080, Project Submittals
E. Section 01150, Project Record Documents and Photographs
F. Section 01160, Training and Operations & Maintenance Manuals
G. Specification Division 2 through 17 as applicable

1.3 QUALITY ASSURANCE

A. The Contractor shall verify that each submittal under this section meets the Contract requirements.
B. Preparation of equipment records shall be done by personnel that meet the following minimum qualifications:
    1. Are specifically trained and certified by the manufacturer in the operation and maintenance of the equipment that they are preparing equipment records;
    2. Have at least 5 years of experience in the operation and maintenance of the equipment they are preparing the equipment records.

1.4 SUBMITTALS

A. Submit documentation that demonstrates that the personnel responsible for preparing the equipment records for each equipment being provided under this Contract meet the minimum qualifications specified in paragraph 1.3 (QUALITY ASSURANCE) of this section.

1.5 FORM OF TECHNICAL DOCUMENTATION SUBMITTAL

A. Insert materials in commercial quality, 8-1/2 inch x 11-inch, 3-ring, green color binders with hardback cleanable plastic covers and 2-inch maximum ring size. When multiple binders are used, correlate data into related, consistent groupings.

B. On binder covers, identify each volume with typed or printed title, "THE DETROIT WATER & SEWERAGE DEPARTMENT – EQUIPMENT RECORDS", listing:

1. Title of project;
2. Area at site;

C. Provide tabbed fly-leaf for each separate equipment, piece of operating equipment or system, with equipment and component descriptions. Provide a table of contents for each volume (binder) identifying each separate product, piece of operating equipment or system included.

D. Text shall be manufacturer's printed data, or neatly word processed on 20-pound (minimum) paper.

E. Submit certification that all data pertains exactly to the model, size, series, etc. of the products / equipment installed on this job.

F. Electronic files:

1. Provide manufacturer’s documentation in electronic format.
2. All text prepared shall be in MS Word or MS Excel format as provided in the blank forms;
3. All electronic files in their native format must be submitted on CD-ROM disks.

1.6 CONTENTS, EACH VOLUME

A. Neatly word processed table of contents for each volume, arranged in systematic order to include the following:

1. Contractor, name of responsible principal, address, fax number and telephone number;
2. A list of each product required to be included, indexed to content of the volume. Identify each product by name and other identifying symbols as set forth in the Contract Documents;
3. List, with each equipment, names, addresses, and telephone numbers of: subcontractor or installer, local source(s) of supply for parts and replacements; manufacturer.

1.7 RECORDS FOR EQUIPMENT.

A. The equipment records shall include:

1. Completed Record of Equipment Data Sheets (see Appendix A),
2. Completed Equipment (Asset) Nameplate Data Sheets (see Appendix B for examples), (Owner will provide the appropriate Equipment (Asset) Nameplate Data Sheet templates for the equipment, which is listed on the Equipment (Asset) Data Sheets.)
3. Completed Equipment Preventive Maintenance Procedures forms (see Appendix C), (Prior to submitting the initial Equipment Preventive Maintenance Procedures form to the Owner, the Contractor shall meet with the Owner to review the Owner’s requirements when completing the forms.)
4. Completed Warranty Data Sheets (see Appendix D),
5. Completed Request to Add a Stock Items and Spare Parts Form (see Appendix E),
6. Completed GIS maps, and specifications (see Appendix F),
7. Completed streamlined Reliability Centered Maintenance analysis for all major equipment. (see Appendix G)
8. Mechanical installer information,
9. Electrical installer information (including instrument & controls supplier information), and
10. All corrective and preventive maintenance records as performed by the Contractor from startup through acceptance of the equipment.

B. Any submittals in which this has not been done will be returned immediately without further review.

1.8 SUBMITTAL SCHEDULE.

A. Submit 5 bound copies of the equipment records and 2 CDs with electronic files to the Engineer for approval 40 days before substantial completion. One copy with review comments will be returned.

B. Submit 5 bound copies of the final documentation and 2 CDs with electronic files to the Engineer for approval 20 days before substantial completion.

PART 2 - PRODUCTS

Not Used.

End of Section

Appendix A

RECORD OF EQUIPMENT DATA SHEET

Appendix B

EQUIPMENT (ASSET) NAMEPLATE DATA SHEET (EXAMPLES)

Appendix C

EQUIPMENT PREVENTIVE MAINTENANCE PROCEDURES FORM

Appendix D

WARRANTY DATA SHEET

Appendix E

REQUEST TO ADD A STOCK ITEM AND SPARE PARTS FORM

Appendix F

GIS MAP AND SPECIFICATIONS

Appendix G

STREAMLINED RELIABILITY CENTERED MAINTENANCE ANALYSIS FOR ALL MAJOR EQUIPMENT

SECTION 01310 PROGRESS SCHEDULE

TABLE OF CONTENTS

PART 1 — GENERAL

1.01 REQUIREMENTS

A. The **Contractor's** approach to prosecution of the Work shall be disclosed to the **Contracting Officer** by submission of computerized, cost-and-resource loaded CPM Progress Schedules as required in this Section. These requirements are in addition to, and not in limitation of, those imposed elsewhere in the Specifications.

B. A *pay Activity*, as opposed to a *CPM Activity*, is an Activity used to simplify cost-loading of the Progress Schedule. When used, pay Activities shall be loaded with the cost of Work that is included, at no cost, in related (generally, concurrent) CPM Activities. Pay Activities shall not control the rate of progress; however, their start and finish dates shall be consistent with those of their related CPM Activities to ensure accurate Early Date and Late Date payment plots. Other defined terms used in this Section have specific intent and meanings assigned in the Glossary. References to CPM (Critical Path Method) shall be CPM standards consistent with this Section.

C. The General Conditions address actions to be taken if the **Contractor** fails, refuses or neglects to provide the required Progress Schedule information on a timely basis.

1.02 QUALITY ASSURANCE

A. The **Contractor** may self-perform the Work covered by this Section or employ a Subcontractor, subject to the **Contracting Officer's** consent, as provided in the General Conditions. Employment of a scheduling Subcontractor shall not in any way alter or reduce the **Contractor's** obligations under the Contract Documents.

B. In preparing Progress Schedules, it is the **Contractor's** responsibility to (a) request interpretations from the **Contracting Officer**, as warranted, (b) point out to the **Contracting Officer**, by specific, separate notation, any aspects of the Progress Schedule that may reflect variations from the Contract Documents, and (c) work with Sub-contractors and Suppliers in finalizing Activities and logic ties.

1.03 PROGRESS SCHEDULE SUBMITTALS

A. The Progress Schedule shall consist of the following Progress Schedule Submittals: (a) Revision Submittals, which may revise the Record Schedule, (b) Payment Submittals, which shall be required for Progress payments, and (c) Proposal Submittals, which shall support proposals or claims for changes in Contract Price or Contract Time, schedule recovery plans and other **Contractor**-initiated Progress Schedule adjustments.

B. A Progress Schedule Submittals shall include a disk with the **Contractor's** files, a narrative and six (6) copies of the following reports, schedules and plots, all in formats, sorts and sequences acceptable to the **Contracting Officer**: (a) Revision Submittals - Detailed Cost Breakdown, Activity reports, Schedule of Values, logic diagrams and resource plots; (b) Payment Submittals - Detailed Cost Breakdown, Activity reports, Schedule of Values and Short Term Schedule; and (c) Proposal Submittals - Detailed Cost Breakdown, Activity reports, Schedule of Values and logic diagram plots.

C. The **Contractor** shall uniquely identify each Progress Schedule Submittal. Resubmissions shall be identified by reusing the corresponding Submittal number and the letter A, B, etc., and shall fully address all the **Contracting Officer's** comments and objections.

D. No Progress Schedule review by the **Contracting Officer** shall relieve the **Contractor** from the responsibility to: (a) comply with the Contract Times and any sequences of Work indicated in or required by the Contract Documents, and (b) complete omitted Work within the Contract Times. Nor will any such Progress Schedule review by the **Contracting Officer** lead to approval of, or consent to, any variation from the Contract Documents, except as the **Contracting Officer** may otherwise approve or consent to individual variations by means of specific, separate notations in writing.

1.04 SUBSTITUTES; ALLOWANCES

A. Progress Schedule Rev. 0 Submittals shall be based solely on the furnishing of named or specified materials/equipment nominated in Section 00450, and the means and methods indicated in or required by the Contract Documents at Bid opening, and shall exclude substitutions - even if the **Contractor** intends to pursue substitutions under the provisions of the Contract Documents. Since the **Contracting Officer's** determination on substitutions may not be made until after the *As-Planned* Schedule is established, the **Contractor** shall plan substitutions accordingly.

B. The **Contractor** shall cause Work covered by Allowances and contingent Unit Price Work to be done within the Contract Times. The Progress Schedule shall incorporate the **Contractor's** best estimate of Activities and logic ties required by all cash allowances and by any Work authorized under any contingent Unit Price Work item.

C. The **Contractor** shall schedule all requisite tasks of the **DWSD** and **Engineer** and all interfaces between the Work and the work of others within the limits of the Contract Times. The Progress Schedule shall incorporate all related Activities and logic ties based on the information given in the Contract Documents, and if not given, as indicated by the **Contracting Officer** in writing.

1.05 DELAY PROVISIONS

A. The **Contractor** shall promptly take appropriate action to recover schedule whenever the **Contractor** anticipates, or any Progress Schedule Submittal demonstrates, and required CPM Activity to slip, due to acts or omissions within the control of the **Contractor**, by fifteen (15) or more days beyond any Target Time or Contract Time. If the **Contractor** is not responsible for such schedule slippage, the **Contractor** shall give prompt written notice of a delay justifying a Contract Time extension, and follow such notice by taking prompt appropriate action nonetheless, if so directed by the **Contracting Officer**.

1. If schedule recovery is required, the **Contractor** shall enclose with the next Payment Submittal a schedule recovery plan consisting of (a) a narrative describing the cause of schedule slippage and the actions taken to recover schedule within the shortest reasonable time, and (b) a Proposal Schedule with the corresponding revisions in Activities and logic ties and other adjustments. Appropriate schedule recovery actions may include, assignment of additional labor, Subcontractors or construction equipment; Work during other than normal working hours; resequencing of the Work; expediting of Submittals and deliveries; and any combination of any of these or other similar actions. Activity shortening and overlapping shall be explained as to their basis (and be supported by increases in resources).

2. If the **Contractor** believes that an increase in Contract Time is justified, any such extension in Contract Time and associated increase in Contract Price will not be evaluated, unless the following requisites are met: (a) the **Contractor**, using the procedures in this Section, demonstrates that conditions justifying extensions in Contract Time or increases in Contract Price, or both, have arisen, and (b) the **Contractor's** analysis is verifiable by an independent, objective evaluation by the **Contracting Officer**, using the electronic files and data furnished by the **Contractor**.

B. The **Contractor's** failure, refusal or neglect to take appropriate schedule recovery action or, in the alternative, give written notice of a delay, and, in either case, to follow up with a timely Proposal Schedule shall be reasonable evidence that the **Contractor** is not prosecuting the Work with due diligence. Any such **Contractor** failure, refusal or neglect shall give sufficient basis to the **DWSD**, with the **Engineer's** advice, to elect any of the following: (a) demand adequate, written assurance of due performance, as provided in the General Conditions, (b) withhold liquidated damages, and (c) in the **DWSD's** sole discretion, direct alternate schedule recovery actions.

C. Once the *As-Planned* Schedule is established, the **Contracting Officer** will select "Targets" (as defined in the Glossary). Targets will be assigned "Target Times" using the Late Dates in the Rev. 0 Record Schedule (*As-Planned* Schedule). As the Record Schedule is revised, Target Times shall be revised to reflect the Late Dates. Target Times shall be interim, **Contractor**-imposed deadlines; however, Target Times shall not be Contract Times.

D. In the event the **Contracting Officer** is unable to return any Progress Schedule Revision as "Resubmittal Not Required", both the **Contracting Officer** and **Contractor** shall be required to use the Rev. 0 Record Schedule and Rev. 0 Target Times, and not any disputed Record Schedule, to resolve issues affecting Contract Time and Contract Price, as follows: (a) The *As-Planned* Schedule will be updated through several Progress Payment closing dates, and (b) actual dates for the Targets shall be compared with the Rev. 0 Target Times, and any slippage, by trade or equivalent Contract phase, shall be correspondingly explained.

1. Any such updating of the *As-Planned* Schedule through a closing date (a) shall purposely exclude all **Contractor**-initiated revisions affecting Work after the closing date, even if such revisions were incorporated into any Revision Submittal (as permitted under paragraph 3.03C), but (b) shall include adjustments in Activities and logic tie changes covering changes and delays that were consented to by the **DWSD** before the closing date. Adjustments in Activities and logic ties for **Contractor**-initiated revisions (including schedule recovery plans) shall be incorporated only in the update for the period when the Work reflected by those **Contractor**-initiated revisions actually took place.

1.06 PROGRESS SCHEDULE SOFTWARE

A. The Progress Schedule software shall be current version of Primavera Project Planner[7] or equivalent software that runs on IBM PC compatible equipment and is capable of: (a) processing and plotting the required Progress Schedule information, and (b) creating data bases accessible by other software.

1.07 MEASUREMENT AND PAYMENTS

A. The **Contractor** represents to have included in the Contract Price all costs for Work under this Section. Payments for Work performed under this Section will be made as part of those payments made on in-progress and completed Detailed Cost Breakdown pay items, or using the Earned Values for Progress Schedule Submittal pay items, if any such pay items are established.

PART 2 — PRODUCTS

2.01 PROGRESS SCHEDULE; NARRATIVE

A. The Progress Schedule shall detail CPM Activities and logic ties to the extent required to show the **Contractor's** overall approach to the Work. Activity breakdown shall be responsive to the intent of paragraphs 2.01.B through 2.02.E and the purpose of the Progress Schedule stated in the General Conditions.

B. The Progress Schedule shall clearly define the prosecution of the Work from Date of Commencement of the Contract Time to final completion by using separate CPM Activities for, but not limited to: construction/installation; permitting (by the **Contractor** and **DWSD**); Submittal preparation; Submittal review and return; Submittal resubmissions and Submittal rereviews, as advisable; deliveries to the site or storage; **DWSD**-furnished items; interfaces with other work (other contractors, public utilities, etc.); testing and Punch List; **DWSD** training; and start-up.

C. CPM Activity durations shall equate to the days required to complete the associated Work. Activities shall not combine: (a) separate items of Unit Price or lump sum Work; (b) distinct classes of Work (e.g., CSI Divisions or equivalent); (c) Work in separate areas, structures or facilities and, if requested by the **Contracting Officer**, Work in separate locations or elevations within an area, structure or facility; or (d) rough-in and finish Work.

D. Installation CPM Activities shall last from fifteen (15) to forty-five (45) days, unless a shorter duration results from the rules in paragraph 2.01.C. Unless longer review times are specified in other Specifications, Submittal review CPM Activities also shall last from fifteen (15) to forty-five (45) days as determined by the **Contracting Officer**. Submittal, delivery and start-up CPM Activities may combine materials and equipment in the same class of Work, based on the detail of related installation CPM Activities.

E. Activities shall be assigned consistent descriptions, codes, and sort codes. Sort code schemes shall: be subject to the **Contracting Officer's** prior consent; indicate whether the **Contractor** (or a Subcontractor or Supplier), **Engineer** or **DWSD** is the lead; distinguish CPM Activities from pay Activities; and group Activities by unit price, area, change, Submittals, deliveries and other such schemes. Constraint dates shall be explained as to basis.

F. A narrative shall list the CPM Activities on each Critical Path and compare Early and Late Dates for CPM Activities designating Contract Times and Target Times. For Payment Submittals, a narrative also shall recap progress and days gained or lost vs. the current Record Schedule, describe changes in resources to be used on remaining Work and identify delays, their extent and causes. For Revision Submittals, the narrative also shall itemize changes in Activities, logic ties and DCB pay items by each change, recovery plan and **Contractor**-initiated revision.

2.02 REPORTS; SCHEDULES; PLOTS

A. Activity reports shall include CPM Activity code, description, duration, calendar, Early and Late Dates (calendar dates), Total Float, labor man-hours and sort codes. The Late Finish Date (or the Early Start Date) of any CPM Activity highlighting a Contract Time (or commencement of all or any part of the Work) shall equal the corresponding Contract Time (or Contract date). In addition, for precedence-based Progress Schedules, Activity reports shall show, for each CPM Activity, all preceding and succeeding logic ties (lead/lag and lead times) or attach a separate report combining such Activity and logic tie data.

B. The Detailed Cost Breakdown (DCB) shall divide the Work into pay items by significant Sections of the Specifications within areas, structures and facilities, or vice versa. If requested by the **Contracting Officer** in writing, there shall be separate DCB reports for self-performed Work and the Work of each Subcontractor.

1. The Schedule of Values (SOV) shall subdivide the DCB into CPM and pay Activities, sequenced by Activity codes, and shall tabulate for each Activity: code, description, Values for labor, Subcontract and/or materials and equipment costs; Activity Values; percent complete; and Earned Values. Delivery and Submittal review Activities, where appropriate, shall be cost-loaded if the **Contractor** intends to request payment for stored materials and for approved equipment Shop Drawings, respectively.

2. Pay Activities or the features of the software shall be used to ensure that any total CPM Activity Value or, if appropriate, that any Activity labor, Subcontract, etc. Values roll up to only one DCB pay item. Once the Rev. 0 DCB and SOV are approved, the **Contractor** shall not modify any DCB pay item or Activity Value, unless otherwise authorized by the **Contracting Officer** in writing.

C. Short-term Schedules shall subdivide CPM Activities into detailed tasks and cover the prior two (2) weeks and the next four (4) weeks. Each installation task shall be cross-referenced to a CPM Activity and shall not combine the Work for more than one crew. Submittals shall segregate preparation from review and shall not combine items furnished by separate Suppliers.

D. Logic diagrams shall be arrow or precedence and, once the **Contracting Officer** has designated time-scales, shall be plotted on a time-scaled calendar, on 24" x 36" sheets. Logic diagrams shall identify the Contract Times and Critical Path(s). CPM Activities shall be shown on the Early Dates, and Total Floats shall be noted beside the CPM Activities. Logic connectors, whether on the same sheet or not, shall identify predecessors and successors.

E. Resource plots shall graph monthly (or weekly, if chosen by the **Contracting Officer**) and cumulative payments and manpower, using current Early Dates and Late Dates and, when requested by the **Contracting Officer**, comparing *As-Planned* Schedule and current Early Dates. The specific trades shall be chosen by the **Contracting Officer**.

PART 3 — EXECUTION

3.01 TOLERANCES

A. If the Early Dates in any Progress Schedule Payment Submittal forecast any slippage in the Contract Times, the

Contractor shall indicate such overrun(s) by reporting negative Total Floats.

B. A Proposal Schedule with negative Total Float or Contract Float over fifteen (15) days will be returned without review, unless the **Contractor** has notified the **DWSD** in writing of delays justifying Contract Time extensions and the Proposal Submittal does reflect the **Contractor's** position on the issues, or unless the **Contracting Officer**, in its sole discretion, elects to otherwise do a review.

C. Total Float and Contract Float in an early completion Revision Submittal or Proposal Submittal shall be determined based on the definitions given in the Glossary, regardless of the float values calculated in any such Progress Schedule Submittal.

3.02 SOFTWARE SUBMITTAL

A. At the pre-construction conference, the **Contractor** shall inform the **DWSD** of the software the **Contractor** will employ to comply with the requirements of this Section.

B. If the **Contractor** selects software not in use by the **DWSD**, the **Contractor**, at no increase in Contract Price, shall (a) furnish a fully-licensed copy to the **DWSD** for the **DWSD** and **Engineer's** use, (b) provide the **DWSD** and **Engineer** with sufficient classroom training, at the site, in the use of the software (as recommended by the software Supplier) and (c) furnish to the **DWSD** all software upgrades/updates acquired from the software vendor during the period allowed for completion of the Work and that are used by the **Contractor** on the Work.

3.03 REVISION SUBMITTALS

A. The first Revision Submittal shall consist of the Detailed Cost Breakdown (DCB) and an Interim Rev. 0 Submittal or the complete Rev. 0 Submittal, if proposed by the **Contractor** and consented to by the **Contracting Officer**. If the Interim Rev. 0 Submittal procedure is enforced, the Interim Rev. 0 Submittal shall be due within ten (10) days after receipt of the Notice to Proceed, and shall consist of the first three (3) months of the forthcoming Rev. 0 Submittal, with the balance of the Work using summary CPM Activities as required to demonstrate compliance with the Contract Times. No Progress Payment shall be finalized until the **Contracting Officer** approves the DCB and returns to the **Contractor** the Interim Rev. 0 Submittal as "Resubmittal Not Required".

1. In addition to the requirements in paragraph 2.02A, the narrative shall detail: (a) the **Contractor's** plan for management of the site (e.g., laydown, staging, traffic, parking, etc.), (b) the use of construction equipment, (c) the buildup of labor in the first three (3) months, and (d) any delays occurring since Contract Award and the potential schedule effect of pending changes.

2. A Payment Submittal progressing the Interim Rev. 0 Submittal shall be due within five (5) days after the closing date of the first three (3) Progress Payments. Progress data and the calculations of Earned Values for DCB pay items and Activities shall comply with the requirements of paragraph 3.04.A-B.

B. The Rev.0 Submittal, representing the first complete Progress Schedule Submittal, shall be due within five (5) days after the closing of the second Progress Payment, or the first one, if the Interim Rev. 0 Submittal is by-passed. The Rev. 0 Submittal shall reflect the Work as awarded, and shall not include any delays, Change Orders, Construction Change Directives or substitutions. The narrative shall itemize shifts, non-Business Days and any multiple calendars applied to the CPM Activities. If the interim Rev. 0 Submittal is by-passed, the narrative also shall comport with the requirements of paragraph 3.03.A.1 and the first three (3) Progress payments shall rely on the DCB and Rev. 0 Submittal.

1. Once the Rev. 0, or Rev. 0A, etc. Progress Schedule is returned to the **Contractor** as "Resubmittal Not Required," with or without comments or objections noted, it shall become the Rev. 0 Record Schedule, or *As-Planned* Schedule, and be used for Payment Submittals until the Record Schedule is revised.

2. The Rev. 0 SOV shall be required for the third Progress Payment, or ten (10) days after establishment of the *As-Planned* Schedule, whichever comes sooner. Except as provided in paragraph 3.03.A.2, or as otherwise determined by the **Contracting Officer**, no Progress Payment shall be finalized until the **Contracting Officer** approves the Rev. 0 SOV and returns to the **Contractor** the Rev. 0 Submittal as "Resubmittal Not Required".

3. Both the DCB and SOV may include separate pay items for mobilization/demobilization, O&M manuals, **DWSD** training, Punch List Work, start-up, etc., if the Contract Documents permit such approach. If the **DWSD** allows Progress Payments to include sums for approved equipment Shop Drawings, the SOV may assign Values to the corresponding Submittal review Activities if: (a) the equipment requires Shop Drawings of significant up-front Contracting Officering and more than ninety (90) days in fabrication, (b) the Activity Value is less than fifteen percent (15%) of the delivered price of the equipment, and (c) such payment will pass in its entirety to the Supplier furnishing the equipment.

C. The Rev. 1 Submittal shall be due three (3) months after establishment of the *As-Planned* Schedule. Subsequent Revision Submittals shall be due every three (3) months after that. Except as recognized in paragraph 3.03.C.2, a Revision Submittal shall be intended to document those agreement reached between the **DWSD** and **Contractor** concerning the Progress schedule by incorporating, in the most recent Payment Submittal, revisions in Activities, logic ties, and so forth, consented to by the **DWSD** upon completion of the **Contracting Officer's** review of the preceding Proposal Submittals. Activity reports, Schedule of Values and logic diagrams shall group revisions in Activities, logic ties, etc. by Change Order, Change Authorization, delay, schedule recovery plan and **Contractor**-initiated revisions.

1. A Revision Submittal returned by the **Contracting Officer** as "Resubmittal Not Required," with or without comments or

objections noted, shall become the Record Schedule to be used by the **Contractor** for subsequent Payment Submittals and Proposal Submittals, and shall be referred to by its Revision number.

2. In the event the **Contracting Officer** is unable to return any Revision Submittal as "Resubmittal Not Required", with or without comments or objections noted, the evolution of the Record Schedule shall cease, however, the **Contractor** shall nonetheless continue to delivery *disputed* Revision, Payment and Proposal Submittals reflecting the **Contractor's** positions on the issues as well as the **Contractor's** approach for Work remaining.

D. The Record Schedule shall reflect the agreements reached between the **DWSD** and **Contractor** concerning the Progress Schedule. Therefore, the current version of Record Schedule shall be used by the **DWSD** and **Contractor** to monitor progress against Contract Times and resolve issues affecting Contract Price and Contract Time and the assessment of liquidated damages, unless the **Contracting Officer** is unable to return any Revision Submittal as "Resubmittal Not Required", in which case the *As-Planned* Schedule shall be used by the **DWSD** and **Contractor**.

3.04 PAYMENT SUBMITTALS

A. Payment Submittals progressing the current version of the Record Schedule shall be due within five (5) days after the closing date of each Progress Payment. The first such Payment Submittal shall be required for the fourth Progress Payment, whether the *As-Planned* Schedule has been established or not.

1. Record Schedules in Payment Submittals shall reflect progress up to the closing date, forecasted finish for in-progress CPM Activities and re-forecasted Early Dates for CPM Activities due to start in the next month, but shall no other adjustments whatsoever in Activities, logic ties or restraint dates.

2. Progress up to the cut-off date shall be limited to changes in logic ties (to reflect out-of-sequence progress) and as-built dates for completed and in-progress CPM Activities using Submittal logs, daily field reports and other pertinent documents. As-built data shall include actual start dates (discounting premature, non-representative starts), remaining duration, Earned Values, actual finish dates (when a CPM Activity was completed and dependent Work could proceed), delays and other significant events experienced since the previous Payment Submittal.

B. For Earned Value for any Activity involving lump sum Work shall equal the product of percent complete, as determined by the **Contracting Officer**, and Activity Value. The Earned Value for any Activity involving Unit Price Work shall equal the product of the actual quantity completed, as determined by the **Contracting Officer**, and the corresponding unit price. Percent complete and Earned Value for each DCB pay item shall be derived from the Earned Values of related CPM Activities and pay Activities.

C. At least one month before a Revision Submittal is due, or more frequently if required, a Payment Submittal shall attach a Proposal Submittal developed using duplicate electronic disk files of the Payment Submittal. A Proposal Schedule shall group affected and added Activities by: (a) each proposal or claim for changes in Contract Time or Contract Price, (b) each schedule recovery plan, and (c) each **Contractor**-initiated revisions. Except as stated by the **Contracting Officer** in writing, the **Contracting Officer's** review of any Proposal Schedules shall not be construed as pre-acceptance of any proposed Activities, logic ties or impacts.

1. For changes in Contract Price or Contract Time, Proposal Schedules shall (a) add all proposed Activities and logic ties required to reflect the changes and delays being negotiated as to responsibility and extent, (b) detail all impacts on pre-existing Activities, logic ties and DCB pay items, and (c) attach separate logic diagrams with the added and pre-existing CPM Activities and logic ties reflecting such changes and delays.

2. Concerning **Contractor**-initiated revisions, Proposal Schedules shall reflect all adjustments made to: (a) CPM Activities and logic ties necessary to recover schedule and reflect the current approach for Work remaining, and (b) DCB pay items and Activity Values required to ensure consistent DCB and SOV cost-loading.

3. Except as otherwise being negotiated, Proposal Schedules shall show how the **Contractor's** approach to prosecution of Work remaining complies with the Contract Times and those sequences of Work contained in the Contract Documents.

D. Each Payment Submittal narrative shall certify that the **Contractor** has not been delayed, as of the cut-off date, by any acts or omissions of the **DWSD** or **Engineer**, except as otherwise specifically stated. Any refusal to so comply shall be resolved as set forth in the General Conditions.

SECTION 01320

MAINTENANCE OF PLANT OPERATIONS

PART I – GENERAL

1.1 SCOPE. This Section describes the requirements for maintenance of plant operations during the construction period.

1.2 GENERAL REQUIREMENTS. The work must be performed in such a manner that continuous, uninterrupted operation of all essential services and facilities are maintained operational throughout the construction period. Work under this Contract shall be so scheduled and conducted by the CONTRACTOR such that work will not impede any treatment process, create potential hazards to operating equipment or personnel, reduce the quality of treatment operations and the plant effluent or cause odor or other nuisance. In performing the work shown or as specified, the CONTRACTOR shall plan and schedule work to meet the plant operating requirements and additional constraints outlined in this Section.

The CONTRACTOR has the option of providing additional temporary facilities that can eliminate a constraint, provided it is done without additional cost to the OWNER, provided that all requirements of these specifications are fulfilled and prior approval from the ENGINEER is obtained. Work not specifically covered in this specification section or not subject to other operating requirements and construction constraints outlined within the applicable specification section(s) shall be performed any time during the contract period. All references to days in this Section are to be construed as consecutive calendar days.

Construction sequences presented in this section outline the intent of the OWNER with respect to the general progress of work. Sequences and construction activities noted are not intended to be comprehensive or all-inclusive. Many other construction activities and work components, although not specifically noted, are integral-parts of the work included in the Contract Documents and must be both scheduled and completed. The ENGINEER will consider sequences other than those specified provided they afford equivalent continuity of wastewater treatment and plant operations. Alternatives to the specified approaches and duration limits are possible; however, deviating from the specified sequences or duration limits will require development of a formal proposal which can be reviewed by the ENGINEER and OWNER. Development and submission of an alternative approach or duration limit does not constitute approval by the ENGINEER and OWNER. The CONTRACTOR must be prepared to execute the Work in concert with the manner and sequences specified herein.

It is the intent of this Section to keep the areas of work in continuous operation by the OWNER to provide pumping and handling of wastewater and its residuals.

The CONTRACTOR shall not shut off or disconnect any operating system of the plant. The OWNER shall execute all plant equipment shutdowns.

For brevity, the CONTRACTOR is advised that this Section of the specifications contains several references to equipment, piping, material, and appurtenances to be removed or reinstalled. The CONTRACTOR shall refer to Specification Section 02050, Demolition and the Contract Drawings for additional details of equipment, piping, material and appurtenances to be demolished and removed from the site by the CONTRACTOR.

1.3 RELATED WORK.

Section 01030, Summary of Work.

Section 01040, Control of Work.

Section 01070, Project Coordination and Meetings.

Section 01310 Progress Schedule.

Section 02050, Demolition.

Section 01180, Equipment, Materials, Parts, and Tools.

Section 01160, Training and O&M Manuals.

1.4 GENERAL CONSTRAINTS. In PART 3: EXECUTION of this Section, the sequence and shutdown of plant systems and process units that are to be taken out of service and demolished or rehabilitated are presented. The CONTRACTOR shall not interrupt the operational status of new or existing units other than the designated units. The ENGINEER may only accept completed work after the specified testing and training has been completed to the satisfaction of the OWNER.

The following constraints shall be applied to all equipment, treatment units and appurtenant utility systems on the plant site.

1.4.01 Access to Plant Site. The CONTRACTOR shall utilize only designated access roads for site access. Any perimeter fence removed, damaged or modified by the CONTRACTOR must be replaced, repaired or returned to permanent status immediately. Temporary security fencing similar to the type and configuration of the permanent fencing may be installed and maintained by the CONTRACTOR with prior authorization from the ENGINEER. All temporary fencing shall be returned to permanent status prior to 95% project completion of the CONTRACTOR'S schedule.

1.4.02 Internal Roads Access. Vehicular access to all treatment units and buildings must be maintained at all times, except when otherwise permitted. All construction traffic on internal roads shall be approved by the ENGINEER and shall not prevent the OWNER'S personnel from gaining access to their work areas.

1.4.03 Access. The OWNER'S and ENGINEER'S personnel must have safe access to all areas that remain in operation throughout the construction period.

The OWNER will remove, as necessary, piping, boxes, pumps, hardware, and other plant property stored in work areas to permit the CONTRACTOR access to the work area. The CONTRACTOR shall make requests for the removal of such material to the ENGINEER and OWNER 30 days in advance of commencing work in that area.

1.4.04 Potable and Secondary Water Systems. The existing potable water (PW) and secondary water (SW) systems shall be kept in operation at all times.

1.4.05 Plumbing Facilities. Except as otherwise permitted, all building plumbing systems such as roof and floor drains, sump pumps, and other systems shall remain in operation at all times.

1.4.06 Building Heating and Ventilating. Operation of building heating and ventilating systems shall be maintained in all structures. Where necessary, the CONTRACTOR shall make provisions to install temporary heating and ventilation systems for structures in which operation of existing or new heating and/or ventilation systems must be interrupted. The ambient temperatures in all interior plant areas shall be maintained at a minimum of 55 degrees F. Minimum ventilation rates shall be equal to the existing rates or, in the case of new structures, the permanent ventilation rate.

1.4.07 Electric Power, Light and Communication Systems. Electric power, lighting service and communication systems shall be maintained in uninterrupted operation in all areas that remain in operation.

Temporary electrical installations for the purpose of maintaining plant operations shall conform to the material and installation requirements of Division 16 of the specifications. Requests for variances from these requirements shall be submitted to the ENGINEER in writing for review and approval.

1.4.08 Sump Pumps and Sumps. All existing sumps and drainage areas where provided for the CONTRACTOR'S use shall be maintained in a satisfactory operating condition with either existing pumps or temporary pumps. If used for the catchment and/or conveyance of drainage, flushing, sludge or other waste liquids during pipe draining, wash down, cleaning, demolition or construction work, sumps will be immediately and thoroughly cleaned by the CONTRACTOR following termination of work in that area. Any failure of a sump pump or plugging of a line during the CONTRACTOR'S use or for a period of five (5) days following its use will be the responsibility of the CONTRACTOR to immediately clean, repair or replace the affected unit to satisfactory condition as determined by the ENGINEER.

1.4.09 Seal and Service Water Piping. Service and seal water and the necessary connections to existing equipment shall be maintained during construction at all times. Work shall not affect existing service and seal water flow, pressure and quantity.

1.4.10 Draining Process Tanks, Pipes and Conduits. The OWNER will drain all Process Tanks, Pipes and Conduits to the extent possible using existing plant drainage facilities. Drainage may be considered successful by the OWNER when 80% or greater of the contents have been removed. Where necessary, due to OWNER'S facilities being unable to drain the contents of pipes, tanks and conduits, the CONTRACTOR shall be responsible for providing temporary drainage equipment.

The CONTRACTOR shall be responsible for dwatering, removal of the contnents , wash down and cleaning as necessary for the performance of his work. A source of secondary water (SW) will be designated when requested by the CONTRACTOR for the purposes of wash down and/or flushing. Uncontrolled or unattended use of SW will not be permitted. During draining, wash down or any cleaning activities by the CONTRACTOR, and if required, the OWNER retains the right to temporarily suspend any water use and draining operations that negatively impact plant operations.

If a drain is not available on the pipe or section of pipe to be drained, then the CONTRACTOR shall install a wet tap using a tapping saddle and valve. No uncontrolled spillage of a pipe's contents shall be allowed and all contents shall be conveyed to an acceptable drainage point by hoses or conduits.

The CONTRACTOR shall immediately wash down any spillage and floor drains. Sumps and sump pump discharge piping shall be flushed clean to prevent clogging and septic odors.

1.4.11 Temporary Partitions and Enclosures. The CONTRACTOR shall furnish and install temporary partitions, and enclosures as required to protect existing equipment and facilities from ongoing construction activities. Temporary partitions shall be installed at all exterior wall penetrations made in existing buildings where equipment or louvers have not yet been installed.

1.4.12 Shutdowns. Any and all shutdowns are to comply with the appropriate "DWSD Standard Equipment Shutdown Request (ESR)" form completed and approved. The CONTRACTOR shall submit the completed forms and any required additional information to the ENGINEER 30 days in advance of the anticipated shutdown.

Following approval of the CONTRACTOR'S shutdown request and at the appointed time, the OWNER shall cause the work to be shutdown, and shall isolate and drain the work to the extent outlined in subsections 1.4.10. The CONTRATOR shall complete the draining, flushing and cleaning as required prior to commencing the work.

a. Shutdown shall be defined to indicate that the normal operation of a plant system or unit process has to be suspended or taken out of service in order to perform the specified work. For each shutdown, the CONTRACTOR shall submit the ESR form, compile an inventory of labor and materials required to perform the tasks, an estimate of the time required and a written description of the steps required to complete the tasks. The ESR form, inventory, time estimate and written procedure shall be submitted to the ENGINEER for review thirty (30) calendar days prior to the start date of the shutdown. The ENGINEER shall submit the request to the OWNER in writing twenty-one (21) days in advance of each planned shutdown. The request shall be reviewed by the OWNER and returned approved or otherwise five (5) calendar days prior to the proposed shutdown date. No shutdown shall be initiated until the ESR form is approved and the ENGINEER has verified that the materials and labor listed are on site at least seven (7) days prior to the proposed start date. The ENGINEER may choose to waive the on-site verification of materials and labor on a case-by-case basis.

b. The work specified herein and any other work required by the OWNER, which may interrupt the normal plant operations, shall be accomplished at such times that will be convenient to the OWNER. Shutdowns may have to be scheduled on off-shifts, weekends and holidays as required.

c. The CONTRACTOR shall also have on hand, located in close proximity to the work area(s), all tools, equipment and materials, both temporary and permanent, necessary to complete each work task, without interruption prior to commencing work. Prefabrication of all piping and other assemblies shall be completed to the greatest degree possible, prior to any shutdowns.

The ENGINEER must be satisfied that the CONTRACTOR has complied with these requirements, to the fullest extent possible, before any shutdowns will be authorized.

1.4.13 Shutdown of Electrical Systems. Shutdown of an electrical system or component requires the CONTRACTOR to submit the appropriate "DWSD Standard Equipment Shutdown Request (ESR)" form. The CONTRACTOR shall submit the completed forms and additional information as required to the ENGINEER 30 days in advance of the anticipated shutdown. The ESR form will delineate the task(s) to be performed, its duration, the areas and service affected, and additional information of relative to alternative power provisions as required. The plan will be submitted to the OWNER for approval 21 days in advance of the anticipated shutdown. Refer to 1.4.12, Shutdowns and the referenced Detroit Wastewater Treatment Plant (DWWTP) procedure. No electrical shutdown activity will be permitted until the ENGINEER and OWNER has provided official authorization to proceed. Following approval and at the CONTRACTOR'S request, the OWNER shall shutdown an existing electric system. The CONTRACTOR shall be responsible for following and implementing the appropriate lock out and tag out procedures for systems de-energized by the OWNER, and shall check cables and wires to be sure that they are de-energized before work begins. Upon completion of the work that necessitated the shutdown, the CONTRACTOR shall remove the locks and advise the ENGINEER that the facilities are available for use.

1.4.14 Overtime. Overtime work by the CONTRACTOR necessary to comply with the requirements of the Contract Documents shall be considered as normal procedure under this Contract, and the CONTRACTOR shall make no claims for extra compensation as a result thereof. The CONTRACTOR shall be prepared to work around-the-clock, weekends and holidays and supply multiple work crews as necessary to complete the work including testing and acceptance as specified, within the specified time frame.

1.4.15 Weather Constrained. Weather conditions as defined below produce increased hydraulic and solids loading to the treatment facility and processes. Initiation of a work item that constrains the process or facility from adequately processing these loadings may cause system imbalance and impact the treated effluent. Weather constrained shall be defined as follows:

a. Weather conditions that produce additional volumes of screenings and grit that must be removed from the treatment system as defined by the OWNER.

When an item is identified as weather constrained, it cannot be initiated if the above conditions apply without prior approval of the ENGINEER.

During times of inclement weather, the CONTRACTOR shall take all necessary steps to ensure an environment acceptable to performing work to include, but not necessarily limited to painting, welding, sandblasting, grouting, finish work, electrical work or other.

1.4.16 Coordination With Utility Companies. The CONTRACTOR shall notify the ENGINEER and request of the appropriate Utility Company to coordinate the relocation, shut off, (re-) energizing of existing or installation of new service as shown on the Drawings, specified herein or as required for the performance of work. The CONTRACTOR submit the appropriate “DWSD Standard Equipment Shutdown Request (ESR)" form. The CONTRACTOR shall submit the completed forms and additional information as required to the ENGINEER 30 days in advance of the anticipated shutdown. The ESR form will delineate the task(s) to be performed, its duration, the areas and service(s) affected, and additional information relative to alternative utility provisions as required. The plan will be submitted to the OWNER for approval 21 days in advance of the anticipated shutdown. Refer to 1.4.12, Shutdowns and the referenced DWWTP procedure. No shutdown activity will be permitted until the ENGINEER and OWNER have provided official authorization to proceed in addition to the proper authorization of the affected Utility.

1.4.17 Illumination.

Construction areas, roadways, offices, shops, corridors, process areas, storage areas, etc. shall be lighted in conformance with OSHA (Electrical, Construction Part 1926) to not less than the minimum illumination intensities (foot candles) listed in Table D.3 of said standard while any work is in progress.

1.5 SEQUENCE OF CONSTRUCTION AND OPERATION. In order to maintain continuous plant operation during construction, a phased removal and construction sequence shall be required as described herein. Specific constraints are outlined for each item. These steps and constraints are intended to provide a required sequence and timing for specific activities related to that particular item. Contract drawings shall take precedence in their interpretation.

1.5.01 Sequence. The work is presented in a logical sequence and does not preclude the CONTRACTOR from advocating changes and/or revisions to the sequence that shall accomplish the work in a similar manner.

The work defined herein shall be incorporated by the CONTRACTOR into the CPM Schedule and updated regularly per the Division 1 Specifications.

While all work within the project scope shall be clearly identified within the schedule, work requiring a system, subsystem, or component shutdown shall be preceded by no less than a 30-day notice to the ENGINEER that the shutdown is planned to occur. The CONTRACTOR is to submit the appropriate "DWSD Standard Equipment Shutdown Request (ESR)" form. Refer to sections 1.4.12 and 1.4.13 for appropriate DWSD shutdown procedure. No shutdown activity will be permitted until the ENGINEER and OWNER have provided official authorization to proceed and the CONTRACTOR is found to be in compliance with the specifications.

The ENGINEER may request additional information relative to the shutdown request, to include a detailed Work Plan for accomplishing the work during the shutdown. The ENGINEER and OWNER as part of the ESR form submittal process shall review this Work Plan. A coordination meeting may be required to ensure that all issues surrounding the accomplishment of the work during the shutdown are addressed and properly accommodated. The meeting will be held no less than seven (7) days prior to the planned work, and shall be attended by the CONTRACTOR, ENGINEER, and OWNER. At this meeting, the CONTRACTOR shall be prepared to review in detail the plan for accomplishing the work and shutdown. The Work Plan shall include, at a minimum:

1. Start time and planned duration of the work.

2. Valves, breakers, circuits and temporary facilities that need to be secured in order to isolate the work to include timing and/or sequencing.

3. Safety Plan.

4. Procedures to drain, flush and clean the work items.

5. CONTRACTOR personnel required to effectively complete the work including supervisory personnel.

6. Tools, equipment and materials to be on hand during the work, including quantities of each.

7. Detailed sequences of work activities to effectively monitor, control, and complete the specific work.

8. Any preparatory work that could / should / must be accomplished prior to initiating the interconnection work.

9. Other work or contracts that are known to be occurring simultaneously and within the vicinity as the proposed work.

10. Or other items pertinent to the shutdown and accomplishment of work that the CONTRACTOR, ENGINEER, or OWNER deem necessary or appropriate to incorporate into the plan.

All materials needed to effectively complete the work shall be procured and on site prior to initiating the shutdown. Where prefabrication and staging of work materials are required by the specifications, the ENGINEER shall review and confirm with the CONTRACTOR that all needed materials are staged at the specific work site no less than 24 hours prior to initiating the shutdown and work. Failure to have all materials properly staged will constitute failure by the CONTRACTOR to be prepared to effectively complete the work, and the work will be canceled and rescheduled via the process described herein.

1.5.02 Tasks. The individual tasks, their steps and constraints are detailed in PART 3, EXECUTION of the section and indexed below:

PART 2 – PRODUCTS

None This Section.

PART 3 – EXECUTION

3.1 SEQUENCING AND OPERATIONS.

3.1.01 General: All equipment shall be tested and shall be in operating condition before the final tie-ins connecting the new equipment to the existing facility are made.

During the course of the work, the shutdown of any services shall be limited to the minimum duration possible and after close coordination with the Owner. However, if requested by the Owner, the Contractor shall ensure the means and methods to provide temporary services in lieu of the services that will be interupted by the construction activities.

3.1.02 Construction Sequence: The construction sequence is intended only to outline critical work items in order to maintain the continuous operation of the wastewater plant. Refer to the plans and specifications for other required work in these areas. Liquidated damages shall be applied if the work is not completed by the specified milestone dates.

End of Section

INDEX

DIVISION 2 - SITE CONSTRUCTION

SECTION 02012

SOIL BORINGS AND TESTING

PART 1 - GENERAL

1.1 SCOPE. This section outlines the standard for conducting geo-technical soil boring investigations and performing laboratory testing on soil samples collected at various locations as indicated on project contract drawings.

1.2 GENERAL. The purpose of the soil boring investigation is to obtain necessary information to determine basic engineering properties of soils. A series of test borings and laboratory tests are performed on the soil samples obtained through the field investigations.

The results of these investigations are presented for the Contractor's information and may be used at his discretion. The Contractor shall assume all risks and responsibilities pertaining to subsurface conditions and shall complete the work under whatever subsurface conditions at no additional cost to the City.

1.2.01 Coordination. The Contractor may make additional soil investigations if considered necessary through coordination with the Engineer. Costs to be borne by the Contractor.

1.2.02 Governing Standards.

ASTM C117 - Test Method for Materials Finer Than 75-m (No. 200) Sieve in Mineral Aggregates by Washing.

ASTM C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM C702 - Practice for Reducing Field Samples of Aggregate to Testing Size.

ASTM D420 - Guide to Site Characterization for Engineering, Design and Construction Purposes.

ASTM D421 - Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

ASTM D422 - Test Method for Particle-Size Analysis of Soils.

ASTM D653 - Terminology Relating to Soil, Rock, and Contained Fluids.

ASTM D1140 - Test Method for Amount of Material in Soils Finer than the No. 200 (75-m) Sieve.

ASTM D1452 - Standard Practice for Soil Investigation and Sampling by Auger Borings.

ASTM D1586 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

ASTM D2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

ASTM D2217 - Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

ASTM D2487 – Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

ASTM D2488 – Practice for Description and Identification of Soils (Visual-Manual Procedure).

ASTM D4220 – Practices for Preserving and Transporting Soil Samples.

ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

ASTM D4427 - Classification of Peat Samples by Laboratory Testing.

ASTM D6066 – Practice for Determining the Normalized Penetration Resistance Testing of Sands for Evaluation of Liquefaction Potential.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. A project specific number of test borings are drilled on the site at various locations identified in contract drawings. The boring locations were approved by Engineer. The test borings were drilled with truck mounted equipment or manually obtained from various elevations below grade.

Drilling methods and standard penetration tests are performed in accordance with the current ASTM D-1452 and D-1586 procedures. These procedures specify that a standard 2-inch (50 mm) O.D. split-barrel sampler be driven by a 140-pound (63.5 kg) hammer with free fall of 30 inches (76.2 cm). The number of hammer blows required to drive the split-barrel sampler through three successive 6-inch (15.2 cm) increments is recorded on the test boring logs in contract documents. The first 6-inch (15.2 cm) increment is use for setting the sampler firmly in the soil and the sum of the hammer blows for the second and third increments is referred to as the "Standard Penetration Index" (N). From the standard penetration test a soil sample is recovered and placed in a container which is sealed to prevent moisture losses during transportation to the laboratory. Standard penetration tests are usually made at depths of 2-1/2 (0.8 m), 5 (1.5 m), 7-1/2 (2.3 m) and 10 feet (3.0 m) and at 5-foot (1.5 m) depth intervals thereafter. These parameters may vary per project conditions.

2.2 LIMITING REQUIREMENTS. Soil test boring samples shall be available for examination anytime during duration of existing project.

2.3 SHOP TESTING.

2.3.01 Laboratory Testing. Testing shall consist of determining the unconfined compressive strength, the natural bulk density, the natural moisture content and other characteristics of the soil samples. In unconfined compression tests, the compressive strength of the soil shall be determined by axially loading a soil sample under slow strain rate until failure is obtained.

Testing shall determine the consistency and relative densities of cohesive and granular soils. The Unified Soil Classification System shall be used for classifying material types by particle sizes based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index and shall be used when precise classification is required per ASTM D2487. This standard is limited to naturally occurring soils. The group names and symbols used in this test method may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, or others. This standard is for qualitative application only. When quantitative information is required for detailed designs of important structures, this test method must be supplemented by laboratory tests or other quantitative data to determine performance characteristics under expected field conditions.

PART 3 – EXECUTION

3.2 PREPARATION.

3.2.01 Soil Boring Logs. The soil conditions encountered in the boring shall be recorded on the individual boring logs as defined in the contract documents. Each log shall record the soil types encountered at that location as well as laboratory test data, ground water data, and other pertinent information. Descriptions of the various soil consistencies, relative densities and particle sizes shall be documented as defined in the contract documents. Additional information can be found in ASTM D653.

End of Section

SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.1 SCOPE. Section includes demolition of designated structures, foundations, slabs-on-grade, sidewalks, and roadways; disconnection and demolition or capping of identified utilities; demolition and removal or filling of underground tanks; and cleanup and removal of demolished materials from the site. Section also includes temporary construction to protect adjacent structures and property against damage and soiling, allow building occupancy, and provide safe access around demolition work. Finally, section includes protection of items to remain.

1.2 GENERAL.

1.2.01 Coordination. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict and promptly submit written report to the Engineer.

1.3 QUALITY ASSURANCE. Accomplish demolition without damaging or soiling existing structures, equipment, and appurtenances that are to remain.

1.3.01 Contractors Qualifications. Contractor shall have a minimum of 5 years experience in construction and similar demolition work.

1.3.02 Hazardous Materials. Certain materials, in areas where the work takes place, may be classified as hazardous to health, the environment and safety by agency regulation or code; regulating the handling, removal, storage and disposal of these materials. Asbestos and lead based paint are examples of hazardous materials which may be encountered. When authorized, the contractor shall utilize personnel having the requisite qualifications to identify, handle, remove, store and dispose of the hazardous materials. Use acceptable techniques in the removal, storage and disposal of these materials.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit a demolition plan for review, describing proposed sequence, methods, and equipment for demolition and disposal of each item or structure prior to any demolition work commencing. Include dust, noise, and odor control measures. Provide inventories of items to be removed and salvaged and items to be removed by Owner.

Provide photographs or videotape, sufficiently detailed, of existing conditions of adjoining structures and site improvements that might be misconstrued as damage caused by selective demolition operations.

Provide product data for any repair materials to Engineer prior to use.

The Contractor shall submit a plan to the Engineer that describes the hazardous materials work and costs before performing the work.

Contractor's Demolition Plan shall take into account all geotechnical conditions.

1.4.02 Certifications. The Contractor shall submit certified copies of all permits, applications and other documentation required by the regulating agency for performance, to completion, of the hazardous materials work. Submit landfill records indicating receipt and acceptance of wastes by a landfill facility licensed to accept these wastes.

1.4.03 Record Drawings. Locate, identify and mark each disconnected service and utility termination point on the project Record Drawings and As-Built Drawings.

1.5 WARRANTY.

1.5.01 Existing Special Warranty. Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Owner assumes no responsibility for actual condition of buildings to be selectively demolished.

The Contractor shall provide 72 hours notice to Engineer of any activities that will affect occupants.

The Contractor shall maintain circulation of traffic within area at all times during demolition operations.

2.2 MATERIALS. Use repair materials identical to existing materials. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match adjacent surfaces to the fullest extent possible and whose installed performance equals or surpasses that of existing materials.

The Contractor shall identify and report, in writing, all hazardous materials identified or brought into Work affected areas that are subject to regulation by federal, state and local law in their handling, storing, removal and disposal. This shall be done before performing the regulated activities.

PART 3 - EXECUTION

3.1 PREPARATION.

3.1.01 Survey Marker Reference Points. Provide three reference points for each survey marker and monument removed, establish by a registered surveyor and record locations and designations of survey markers and monuments prior to removal.

Store removed markers and monuments during demolition work, and replace upon completion of work. Reestablish survey markers and monuments in conformance with recorded reference points. Provide documentation verifying reestablishment of survey markers and monuments, signed by registered surveyor.

3.1.02 Disconnection of Utility Service. Locate, identify and mark each existing service and utility to be disconnected, at the termination points. Arrange with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to demolition work. Obtain permission before abandoning or removing any existing structures, materials, equipment and appurtenances. Verify that services and utilities are disconnected and capped prior to beginning demolition.

3.1.03 Protection. Prior to beginning work, provide suitable protection such that the Work shall not hinder or interfere with use of adjacent building spaces in any way, for any purpose. Passageways to, from, and between building spaces adjacent to the Work shall be maintained free and clear of obstruction and safe for normal occupancy and intended use at all times. Cap or plug pipes and other conduits abandoned due to demolition as indicated on drawings or as specified.

3.2 PERFORMANCE. Carefully remove materials to be reused and salvaged. Such materials shall be suitably cleaned and dismantled, moved to designated storage areas, protected from weathering, staining, construction damage, theft and vandalism, and arranged to facilitate inspection. Carefully handle, assemble and reinstall materials to be reused, in undamaged and usable condition. Delmer material to be salvaged to the Owner as directed by Engineer.

Repair or remove items that are damaged. Repair and installation of damaged items shall be at no additional compensation and to condition at least equal to that, which existed prior to start of work. Replace materials that are damaged by the Work with suitable equivalent new materials.

3.2.01 Demolition. Execute the Work in a careful, orderly manner. Provide and maintain barriers, dust screens, ventilation, and warning lights as may be necessary to protect persons and property. Perform the Work with care, using tools and methods that will not transfer any heavy shocks to adjacent structures. Prevent conditions, obstructions, contamination, vibrations or disturbances that are hazardous. Conduct the Work in a manner giving prime consideration to, but not necessarily limited by:

Protection of the public, the Owners property, the Work, and of the existing adjacent structures.

Protection from adverse weather.

Control and prevention of unwanted sounds (noise), shocks, and vibration, dirt and dust.

Provision and maintenance of safe and orderly ingress, access and egress to, within and from the Work.

Coordination and cooperation with the Owner through the Engineer.

Remove from the project site and legally dispose of the removed materials not reused and salvaged.

3.2.02 Debris Removal. Remove from the project site and legally dispose of all debris resulting from the Work. Debris shall not be accumulated.

Maintain the work areas free of debris and swept broom clean at all times.

Provide and maintain readily accessible debris containers, appropriate and suitable for the type of refuse and local work conditions, and as designated and approved by the Engineer.

Clean each active work area no less than once each workday. Empty each debris container and remove all debris from each active work area no less than once each workday, and more often as necessary to prevent obvious accumulation and hazardous conditions.

3.2.03 Salvage.

A. Materials, equipment and appurtenances removed, that are not designated for relocation, shall become the property of Contractor and shall be hauled from site and disposed of at no additional cost to the Owner.

B. Material salvaged from this work shall not be reused, except, where reuse is specifically indicated in the Contract Documents, or when the equipment is to be turned over to the Owner for reuse.

C. Store equipment to be salvaged for relocation where directed by Engineer, and protect from the elements and damage during work. Other materials, equipment and appurtenances removed and designated for salvage by the Owner shall also be stored where directed by the Engineer.

3.2.04 Hazardous Materials. The Contractor shall execute the hazardous materials work in compliance with the laws and regulations governing the work. The Contractor shall be fully responsible for this work.

End of Section

SECTION 02080

ASBESTOS REMOVAL

PART 1 - GENERAL

1.1 SCOPE. The work covered by this section includes the handling of primarily nonfriable materials containing asbestos which are encountered during removal and demolition operations and the incidental procedures and equipment required to protect workers and occupants of the building or area, or both, from contact with airborne asbestos fibers. The work also includes the disposal of the removed asbestos containing materials.

1.1.01 Description of Work. The work specified herein shall be the removal of asbestos containing materials by competent persons trained, knowledgeable and qualified in the techniques of abatement, handling and disposal of asbestos-containing and asbestos-contaminated areas, who comply with all applicable Federal, State, and Local regulations and are capable of and willing to perform the work of this Contract.

The Contractor shall supply all labor, materials, services, insurance, permits and equipment necessary to carry out the work in accordance with all applicable Federal, State, and Local regulations and these specifications.

The Contractor is responsible for restoring the work area and auxiliary areas utilized during the abatement to conditions equal to or better than original. Any damage caused during the performance of abatement activities shall be repaired by the Contractor (e.g. paint peeled off by barrier tape, nail holes, water damage, broken glass) at no additional expense to the Owner.

1.2 GENERAL.

1.2.01 Coordination. Prior to commencement of work, the Contractor shall send written notification in accordance with 40 CFR Part 61.146 of Subpart M, to the appropriate State or Federal Air Pollution Control Agency responsible for the enforcement of the National Emission Standard for Asbestos at least 10 days prior to the commencement of any on-site project activity. Provide a copy of the notice to the Engineer.

Submit proof that required permits, site location and arrangements for transport and disposal of asbestos containing waste materials have been made. Obtain and submit a copy of handling procedures and list of protective equipment utilized for asbestos disposal at the Landfill, signed by the Landfill Owner. (Required for all abatement projects.) DWSD will assign an Asbestos Removal Coordinator for the project. Coordinate all abatement work and related activities with the Coordinator.

1.2.02 Governing Standards. All work under this contract shall be done in strict accordance with all applicable Federal, State, and Local regulations, standards and codes governing asbestos abatement and trade work done in conjunction with the abatement.

OSHA (Occupational Safety and Health Administration) - Title 29 Code of Federal Regulations Section 1910.1001 – General Industry Standard for Asbestos.

OSHA – Title 29 Code of Federal Regulations Section 1910.134 – General Industry Standard for Respiratory Protection.

OSHA – Title 29 Code of Federal Regulations Section 1926 Construction Industry.

OSHA – Title 29 Code of Federal Regulations Section 1910.1020 Access to Employees Exposure and Medical Records.

OSHA – Title 29 Code of Federal Regulations Section 1910.1200 Hazard Communication.

EPA – Title 40 Code of Federal Regulations Part 61 Subparts A and M (Revised Subpart B) – National Emission Standard for Asbestos.

EPA 560/S-83-002 – Guidance for Controlling Friable Asbestos – Containing Materials in Buildings.

The most recent edition of any relevant regulation, standard, document or code shall be in effect. Where conflict among the requirements or with these specifications exists, the most stringent requirements shall be utilized.

Copies of all standards, regulations, codes and other applicable documents, including this specification and those listed as specific requirements shall be available at the work site in the clean change area of the worker decontamination system.

1.2.03 Site Security. Work area is to be restricted only to authorized, trained and protected personnel, including the Engineer or designated representative, employees, Contractor's employees, subcontractor employees, Owner employees and representatives, State and Local inspectors and any other designated individuals. A list of authorized personnel shall be established prior to job start and posted in the clean room of the work decontamination.

Entry into the work area by unauthorized individuals shall be reported immediately by the Contractor.

A logbook shall be maintained in the clean room area of the worker decontamination system. Anyone who enters the work area must record name, affiliation, time in, and time out for each entry.

Access to the work area shall be through a single worker decontamination system located at worksite. All other means of access (doors, windows, hallways, etc.) shall be blocked or locked so as to prevent entry to or exit from the work area. The only exceptions for this rule are the waste pass-out airlock, which shall be sealed except during the removal of containerized asbestos.

1.3 QUALITY ASSURANCE.

1.3.01 Contractors Qualifications. The Contractor shall submit a notarized statement, signed by an officer of the company, containing a record of any citations issued by Federal, State, or Local regulatory agencies relating to asbestos abatement activity. Include projects, dates, and resolutions.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings for layouts and construction of decontamination enclosure system and barriers for isolation of the work area as detailed in this specification and required by applicable regulations.

Inspect the premises wherein all abatement and abatement related activities will occur and submit a signed statement, verifying building and fixture condition prior to the commencement of work.

1.4.02 Certifications. Submit manufacturer's certification that high-efficiency particulate air (HEPA) filter vacuum, negative pressure ventilation units and other local exhaust ventilation equipment conform to ANSI Z9.2-79.

When rental equipment is to be used in abatement areas or to transport asbestos contaminated waste, a written notification concerning intended use of the rental equipment must be provided to the rental agency. Submit a copy of this notification.

Document NIOSH approvals for all respiratory protective devices utilized on site. Include manufacturer certification of HEPA filtration capabilities for all cartridges and filters.

Submit documentation that the Contractor's employees, including foremen, supervisors and any other company personnel or agents who may be exposed to airborne asbestos fibers or who may be responsible for any aspects of abatement activities, have received adequate training that includes, at a minimum, training described in paragraph 3.1.08 of this specification.

Submit documentation from a physician that all employees or agents who may be exposed to airborne asbestos in excess of background level have been provided with an opportunity to be medically monitored to determine whether they are physically capable of working while wearing the respirator required without suffering adverse health effects. In addition, document that personnel have received medical monitoring as required in OSHA 29 CFR 1910.1001 (j). The Contractor must be aware of and provide information to the examining physician about unusual conditions in the workplace environment (e.g. high temperatures, humidity, chemical contaminants) that may impact on the employee's ability to perform work activities.

Submit documentation of respirator fit testing for all Contractor employees and agents who must enter the work area. This fit-testing shall be in accordance with qualitative procedures as detailed in OSHA Lead Standard 29 CFR 1910.1025 Appendix D Qualitative Fit Test Protocol or be quantitative in nature.

1.4.03 Test Reports. During abatement activities, the Contractor shall submit weekly job progress reports detailing abatement activities. Include review of progress with respect to previously established milestones and schedules, major problems and action taken, injury reports, equipment breakdown and bulk material and air sampling results conducted by Contractor's Air Sampling Professional.

Submit per-abatement air sampling results. Include location of samples, name of Air Sampling Professional, equipment, and methods utilized for sampling and analysis.

Submit copies of all transport manifests, trip ticket and disposal receipts for all asbestos waste materials removed from the work area during the abatement process.

Provide copies of the weekly reports to the DWSD Asbestos Removal Coordinator and verify with Coordinator areas that require abatement work to be performed.

Submit daily, copies or work site entry logbooks with information on worker and visitor access.

Submit logs documenting filter changes on respirators, HEPA vacuums, negative pressure ventilation units, and other engineering controls.

Submit results of bulk material analysis and air sampling data collected during the course of the abatement including OSHA compliance air monitoring results.

Submit results of materials testing conducted during the abatement for purposes of utilization during abatement activities (e.g. testing of encapsulates for depth of penetration, testing of substitute materials for adherence to encapsulated surfaces). Post in the clean room area of the worker decontamination enclosure a list containing the names, addresses, and telephone numbers of the Contractor, the Engineer, the Asbestos Project Officer, the General Superintendent, the Air Sampling Professionals, the testing laboratory and any other personnel who may be required to assist during abatement activities (e.g. Safety Officer, Building Maintenance Supervisor, Energy Conservation Officer).

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver all materials in the original packages, containers or bundles bearing the name of the manufacturer and the brand name (where applicable).

Store all materials subject to damage off the ground, away from wet or damp surfaces and under cover sufficient enough to prevent damage or contamination. Replacement materials shall be stored outside of the work area until abatement is completed.

Damaged, deteriorating or previously used materials shall not be used and shall be removed from the work site and disposed of properly.

PART 2 - PRODUCTS

2.1 MATERIALS. Polyethylene sheeting for walls and stationary objects shall be a minimum of 4-mil (0.1 mm) thick. For floors and all other uses, sheeting of at least 6-mil (0.2 mm) thickness shall be used in widths selected to minimize the frequency of joints.

Method of attachment may include any combination of duct tape or other waterproof tape, furring strips, spray glue, staples, nails, screws or other effective procedures capable of sealing adjacent sheets of polyethylene and capable of sealing polyethylene to dissimilar finished or unfinished surfaces under both wet and dry conditions (including the use of amended water).

Polyethylene sheeting utilized for worker decontamination enclosure shall be opaque white or black in color.

Disposal bags shall be of 6-mil (0.2 mm) polyethylene, per-printed with labels as required by EPA regulation 40 CFR 61.152 (b) (i) (iv) or OSHA requirement 29 CFR 19100.1001 (g) (2) (ii).

Disposal drums shall be metal or fiberboard with locking ring tops.

2.1.01 Removal. Surfactant (wetting agent) shall be a 50/50 mixture of polyoxyethylene ether and polyoxyethylene ester, or equivalent, mixed in a proportion of 1 fluid ounce to 5 gallons (1.56 ml to 1 liter) of water or as specified by manufacturer. (An equivalent Surfactant shall be understood to mean a material with a surface tension of 29 dynes/cm as tested in its properly mixed concentration, using ASTM method D1331-56-"Surface and Interfacial Tension of Solutions of Surface Active Agents.") Where work area temperature may cause freezing of the amended water solution, the addition of ethylene glycol in amounts sufficient to prevent freezing is permitted.

2.1.02 Enclosure. The enclosures shall be constructed of materials such that when the enclosure is completed there is limited potential for impact damage to the enclosure and no potential for fiber release.

2.2 EQUIPMENT.

2.2.01 General. A sufficient quantity of negative pressure ventilation units equipped with HEPA filtration and operated in accordance with ANSI 29.2-79 (local exhaust ventilation requirements) and EPA 560/5-83-002 Guidance for Controlling Friable Asbestos-Containing Materials in Buildings, Appendix F: Recommended Specifications and Operating Procedures for the Use of Negative Pressure Systems for Asbestos Abatement shall be utilized so as to provide one workplace air change every 15 minutes.

To calculate total air flow requirement:

Total ft^3/min (m^3/min) = Vol. of work area (in ft^3/m^3)/ 15 min

To calculate the number of units needed for the abatement:

Number of units needed = [Total ft^3 (m^3)/min]/[Capacity of unit in ft^3 (m^3)/min]

If air supplied respirators are utilized, estimate the volume of supplied air and add to workplace air volume when calculating ventilation requirements. For small enclosures and glove bags, a HEPA filtered vacuum system may be utilized to provide negative air pressure.

Type "C" air supplied respirators in positive pressure or pressure demand mode with full facepieces and HEPA filtered disconnect protection are recommended by the U.S. EPA for all full shift abatement work until the successful completion of final clearance of air monitoring. Powered air purifying respirators equipped with HEPA filters and full facepieces or respirators with a higher National Institute of Occupational Safety and Health (NIOSH) assigned protection factor may be used for inspection or repair work of less than 1 hour duration per day. A sufficient supply of charged replacement batteries and filters and a flow test meter shall be available in the clean change area for use with powered air purifying respirators. Air purifying respirators with dual high-efficiency (HEPA) filters may be utilized during work area preparation activities. Spectacle kits and eyeglasses must be provided for employees who wear glasses and who must wear full facepiece respirators. Respirators shall be provided that have been tested and approved by the NIOSH for use in asbestos.

Compressed air systems shall be designed to provide air volumes and pressures to accommodate respirator manufacturer's specifications. The compressed air systems shall have adequate capacity to allow escape of all respirator wearers from contaminated areas in the event of compressor failure. Compressors must meet the requirements of 29 CFR 1910.134 (d). Compressors must have an in-line carbon monoxide monitor and period, inspection of the carbon monitor must be evidenced. Documentation of adequacy of compressed air systems/respiratory protection system must be retained on site. This documentation will include a list of compatible components with the maximum number and type of respirators that may be used with the system. Periodic testing of compressed air shall insure that systems provide air of sufficient quality (Grade D breathing air as described in Compressed Gas Association Commodity Specifications G-7.1).

Full body disposable protective clothing, including head, body and foot coverings consisting of material not penetrable by asbestos fibers (Tyvek R or equivalent) shall be provided to all workers and authorized visitors in sizes adequate to accommodate movement with out tearing.

Additional safety equipment (e.g. hard hats) meeting the requirements of ANSI standard Z89.1-1981, eye protection meeting the requirements of ANSI Standard Z87.1-1979, safety shoes meeting the requirements of ANSI Standard Z41.1-1967, disposable PVC gloves), as necessary, shall be provided to workers and authorized visitors.

Non-skid footwear shall be provided to all abatement workers. Disposable clothing shall be adequately sealed to the footwear to prevent contamination.

If launderable clothing is to be worn underneath disposable protective clothing, it shall be provided by the Contractor to all abatement workers. (It is recommended that launderable clothing be a unique, specific color to enable it to be distinguished from general purpose blue, gray or black coveralls that are commonly worn.) Laundering must occur in accordance with 29 CFR 1910.1001 (d) (4) (iii) however, a sufficient supply of disposable mops, rags and sponges for work area decontamination shall be available.

2.2.02 Removal. A sufficient supply of scaffolds, ladders, lifts and hand tools (e.g. scrapers, wired cutters, brushes, utility knives, wire saws, etc.) shall be provided as needed.

Sprayers with pumps capable of providing 500 psi (3447.4 kPa) at the nozzle for spraying amended water.

Rubber dust pans and rubber squeegees shall be provided for cleanup.

Brushes utilized for removing loose asbestos containing material shall have nylon or fiber bristles, not metal.

A sufficient supply of HEPA filtered vacuum systems shall be available during cleanup.

2.2.03 Enclosure. Hand tools equipped with HEPA filtered local exhaust ventilation shall be utilized during the installation of enclosures and supports if there is any need to disturb asbestos containing materials during this process. (As an alternative, asbestos material may be partially removed following proper removal procedures prior to the installation of supports and enclosures.

2.3 SUBSTITUTIONS.

2.3.01 Approval Required. The Contract is based on the materials, equipment and method described in the Contract Documents.

The Contractor will consider proposals for substitutions of materials, equipment and methods only when such proposals are accompanied by full and complete technical data and all other information required by the Contractor to evaluate the proposed substitution.

Do not substitute materials, equipment or methods unless such substitution has been specifically approved for this work by the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION.

3.1.01 Abatement Notification. Prior to commencement of work, the Engineer shall notify occupants of work areas that may be disrupted by the abatement of project dates and requirements for relocation. Arrangements must be made prior to start, for relocation of desks, files, equipment and personal possessions to avoid unauthorized access into the work area.

Notification of all building occupants and users is recommended in order to prevent unnecessary or unauthorized access to the contaminated work area.

Refer to Paragraph 1.2.01 of this section for government agency requirements.

Document that Owner's employees or designated representatives who will be required to enter work area during abatement have received training equal to that detailed in paragraph on training. (This training may be provided by the Contractor.)

Provide to the Contractor information concerning access, shutdown and protection requirements of certain equipment and systems in the work area.

3.1.02 Work Areas. Post caution signs meeting the specifications of OSHA 29 CFR 1910.1001 (g) (1) (ii) at any location and approaches to a location where airborne concentrations of asbestos may exceed ambient background levels. Signs shall be posted at a distance sufficiently far enough away from the work area to permit an employee to read the sign and take the necessary protective measures to avoid exposure. Additional signs may need to be posted following construction of workplace enclosure barriers.

Shut down and lock out electric power to all work areas. Provide temporary power and lighting. Insure safe installation (including ground faulting) of temporary power sources and equipment by compliance with all applicable electrical code requirements and OSHA requirements for temporary electrical systems. All costs for electrical systems shall be paid for by the Contractor.

Shut down and lock out all heating, cooling and air conditioning system (HVAC) components that are in, supply or pass through the work area.

Interiors of existing duct work may require decontamination. This may be done during the pre-cleaning phase of operations before the duct work is sealed off or during the final cleaning phase prior to reengagement of the system. Appropriate equipment and control measures shall be utilized to prevent contamination of building spaces during this operation. Adequate cleaning of duct work may sometimes be accomplished by drawing high volumes of air through the system using the HEPA filtered negative pressure ventilation units.

Investigate the work area and agree on preabatement condition with Engineer. Seal all intake and exhaust vents in the work area with tape and 6-mil (0.2 mm) polyethylene. Also seal any seams in system components that pass through the work area. Remove all HVAC system filters and place in label 6-mil polyethylene bags for staging and eventual disposal as asbestos contaminated waste.

The Contractor shall provide sanitary facilities for abatement personnel outside of the enclosed work area and maintain them in a clean and sanitary condition throughout the project.

The Owner will provide water for construction purposes. Contractor shall connect to existing plumbing system.

Preclean all movable objects within the work area using a HEPA filtered vacuum and/or wet cleaning methods as appropriate. After cleaning, these objects shall be removed from the work area and carefully stored in an uncontaminated location.

Preclean all fixed objects in the work area using HEPA filtered vacuums and/or wet cleaning techniques as appropriate. Careful attention must be paid to machinery behind grills or gratings where access may be difficult but contamination may be significant. Also pay particular attention to wall, floor and ceiling penetrations behind fixed items. After precleaning, enclose fixed objects in 4-mil (0.1 mm) polyethylene sheeting and seal securely in place with tape. These shall be designated and enclosures constructed with access flaps sealed with waterproof tape.

Preclean all surfaces in the work area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Do not use any methods that would raise dust such as dry sweeping or vacuuming with equipment not equipped with HEPA filters. Do not disturb asbestos containing materials during the precleaning phase.

Seal off all windows, doorways, elevator openings, corridor entrances, drains, ducts, grills, grates, diffuses, skylights and any other openings between the work area and uncontaminated areas outside of the work area (including the outside of the building, tunnels and crawl spaces) with 4-mil (0.1 mm) polyethylene sheeting and tape (isolating work area from occupied areas).

Cover floors in the work area with polyethylene sheeting.

Floor shall be covered with 2 layers of 6-mil (0.2 mm) minimum sheeting. Additional layers of sheeting may be utilized as drop cloths to aid in cleanup of bulk materials.

Plastic shall be sized to minimize seams. If the floor area necessitates seams, those on successive layers of sheeting shall be staggered to reduce the potential for water to penetrate to the flooring material. A distance of at least 6 feet (1.83 m) between seams is sufficient. Do not locate any seams at wall/floor joints.

Floor sheeting shall extend at least 12 inches (30.48 cm) up the sidewalls of the work area.

Sheeting shall be installed in a fashion so as to prevent slippage between successive layers of material. (Vinyl sheeting may be used for improved traction on floors.)

Cover walls in the work area with polyethylene sheeting. Walls that are non-porous and will not be damaged by water, surfactant, encapsulation do not necessarily need protection. They can be decontaminated using HEPA vacuums and wet cleaning techniques. Walls with mortar joints (e.g. tile) are considered porous. In addition, opening through these walls to uncontaminated areas of the building must be sealed.

Walls shall be covered with 2 layers of 4-mil (0.1 mm) polyethylene sheeting. Plastic shall be sized to minimize seams. Seams shall be staggered and separated by a distance of a least 6 feet (1.83 m).

Wall sheeting shall overlap floor sheeting by at least 12 inches (30.48 cm) beyond the wall/floor joint to provide a better seal against water damage and for negative pressure.

Wall sheeting shall be secured adequately to prevent it from falling away from the walls. This will require additional support/attachment when negative pressure ventilation systems are utilized.

3.1.03 Worker Decontamination Enclosure Systems. Worker decontamination enclosure systems shall be provided at all locations where workers will enter or exit the work area. One system at a single location for each contained work area is preferred. These systems may consist of existing rooms outside of the work area, if the layout is appropriate, that can be enclosed in plastic sheeting and are accessible from the work area. When this situation does not exist, enclosure systems may be constructed out of metal, wood or plastic support as appropriate.

Plans for construction, including materials layout, shall be submitted as shop drawings prior to work initiation. Worker decontamination enclosure systems constructed at the work site shall utilize 6-mil (0.2 mm) opaque black or white polyethylene sheeting or other acceptable materials for privacy. Detailed descriptions of portable, pre-fabricated units, if used, must be submitted. Plans must include floor plan with dimensions, material, size, thickness, plumbing and electrical utilities.

The worker decontamination enclosure system shall consist of at least a clean room, a shower room, and an equipment room, each separated from each other and from the work area by airlocks.

Entry to and exit from all airlocks and decontamination enclosure system chambers shall be through curtained doorways consisting of 2 sheets of overlapping polyethylene sheeting. One sheet shall be secured at the top and left side, the other sheet at the top and right side. Both sheets shall have weights attached to the bottom to insure that they hang straight and maintain a seal over the doorway when not in use. Doorway designs, providing equivalent protection may be utilized.

Access between any 2 rooms in the decontamination enclosure system shall be through an airlock with at least 3 feet (91.44 cm) separating each curtained doorway.

Pathways into (from clean to contaminated) and out from (contaminated to clean) the work area shall be clearly designated.

Clean room shall be sized to adequately accommodate the work crew. Benches shall be provided as well as hooks for hanging up street clothes. (Lockers may be provided for valuables, however, workers may be requested to secure valuables in their cars.) Shelves for storing respirators shall also be provided in this area. Clean work clothes, clean disposable clothing, replacement filters for respirators, towels and other necessary items shall be provided in adequate supply at the clean room. A location for posting shall also be provided in this area. Whenever possible, a lockable door shall be used to permit access into the clean room from outside the work area. Lighting, heat and electricity shall be provided as necessary for comfort. This space shall not be used for storage of tools, equipment or materials (except as specifically designated) or as office space.

Shower room shall contain 1 or more showers as necessary to adequately accommodate workers. Each shower head shall be supplied with hot and cold water adjustable at the tap. The shower enclosure shall be constructed to ensure against leakage of any kind. An adequate supply of soap, shampoo and towels shall be supplied by the Contractor and available at all times. Shower water shall be drained, collected, and filtered through a system with at least 0.5-1.0 micron particle size collection capability. A system containing a series of several filters with progressively smaller pore sizes is recommended to avoid rapid clogging of filtration by particles.

The equipment room shall be used for storage of decontaminated equipment and tools. At the end of a shift, all equipment and tools shall be decontaminated using a HEPA filtered vacuum and/or wet cleaning techniques as appropriate. Other equipment, tools and materials, which may be required during the abatement, may also be stored in the equipment room. These items include replacement filters for HEPA vacuums and negative pressure ventilation equipment, spare tools, and containers of surfactant. Replacement filters are to be kept in sealed containers until they are required for use. A walk-off pan (a small children's swimming pool or equivalent filled with water) shall be located in the work area just outside the equipment room. Workers shall use the walk-off pan to clean off foot coverings after leaving the work area and to prevent excessive contamination of the worker decontamination enclosure system. A drum shall be located in the equipment room for collection of disposable clothing. Drums shall be lined with a label 6-mil (0.2 mm) polyethylene bags. Contaminated footwear (e.g. rubber boots or other reusable footwear) shall be stored in this area for reuse the following work day.

The waste container pass-out airlock shall be constructed at some location away from the worker decontamination enclosure system. Wherever possible, this shall be located where there is direct access from the work area to the outside of the building.

This airlock system shall consist of an airlock, a container staging area, and another airlock with access to outside the work area.

The waste container pass-out airlock shall be constructed in similar fashion as the worker decontamination enclosure system using similar materials and airlock and curtain doorway designs.

This airlock system shall not be used to enter or exit the worksite.

Emergency exits shall be established and clearly marked with duct tape arrows or other effective designations to permit easy location from anywhere within the work area. They shall be secured to prevent access from uncontaminated areas and still permit emergency exiting. These exits shall be properly sealed with polyethylene sheeting, which can be cut to permit egress if needed. These exits may be the worker decontamination enclosure, the waste pass-out airlock and/or other alternative exits satisfactory to fire officials.

3.1.04 Isolation of the Work Area from Occupied Areas of the Building. The contaminated work area shall be separated from uncontaminated, occupied areas of the building by the construction of airtight barriers.

Walls shall be constructed of wood or metal framing to support barriers in all openings larger than 4' X 8' (1.22 m x 2.44 m). A sheathing material (plywood, drywall) of at least 3/8" (9.5 mm) thickness shall be applied to work side of barrier. Cover both sides of partition with double layer of 6-mil (0.2 mm) polyethylene sheeting with staggered joints and seal in place. Caulk edges of partition at floor, ceiling, walls and fixtures to form an airtight seal.

3.1.05 Maintenance of Workplace Barriers and Worker Decontamination Enclosure Systems. Following completion of the construction of all polyethylene barriers and decontamination system enclosures, allow over night settling to insure that barriers will remain intact and secured to walls and fixtures before beginning actual abatement activities.

All polyethylene barriers inside the workplace, in the worker decontamination enclosure system, in the waste container pass-out airlock and at partitions constructed to isolate the work area from occupied areas shall be inspected at least twice daily, prior to the start of each day's abatement activities and following the completion of the day's abatement activities. Document inspections and observations in the daily project log. Damage and defects in the enclosure system are to be repaired immediately upon discovery. Use smoke tubes to test the effectiveness of the barrier system when directed.

At any time during the abatement activities after barriers have been erected, if visible material is observed outside of the work area or if damage occurs to barriers, work shall immediately stop, repairs be made to barriers, and debris/residue cleaned up using appropriate HEPA vacuuming and wet mopping procedures.

If air samples collected outside of the work area during abatement activities indicate airborne fiber concentrations greater than 0.16 f/in^3 (0.01 f/cm^3) or pre-measured background levels (whichever is lower), work shall immediately stop for inspection and repair of barriers. Cleanup of surfaces outside of the work area using HEPA vacuums or wet cleaning techniques may be necessary.

Install and initiate operation of negative pressure ventilation equipment as needed to provide one air change in the work area every 15 minutes. Openings made in the enclosure system to accommodate these units shall be made air tight with tape and/or caulking as needed. If more than one unit is installed, they should be turned on one at a time, checking the integrity of wall barriers for secure attachment and need for additional reinforcement. Insure that adequate power supply is available to satisfy the requirements of the ventilating units. Negative pressure ventilation units shall be exhausted to the outside of the building whenever feasible. They shall not be exhausted into occupied areas of the building. Twelve inch (30.48 cm) extension ducting shall be used to reach from work area to the outside when required. Careful installation, air monitoring and daily inspections shall be done to insure that the ducting does not release fibers into uncontaminated building areas.

Once constructed and reinforced as necessary, with negative pressure ventilation units in operation as required, test enclosure for leakage utilizing smoke tubes, repair or reconstruct as needed.

Clearly identify and maintain emergency and fire exits from the work area.

Remove, clean and enclose in polyethylene the ceiling mounted objects such as lights and others items that may interfere with the abatement process and were not previously cleaned and sealed off. Utilize localized spraying of amended water and/or HEPA vacuums to reduce fiber dispersal during the removal of these fixtures.

3.1.06 <u>Commencement of Work</u>. Work shall not begin until the following actions occur:

Enclosure systems have been constructed and tested.

Negative pressure ventilation systems are functioning adequately.

All pre-abatement submissions, notifications, posting and permits have been provided to the Engineer.

All equipment for abatement, clean-up and disposal are on hand.

All worker training (and certification) is completed.

3.1.07 Personnel Entry/Exit/Procedure. All workers and authorized personnel shall enter the work area through the worker decontamination enclosure system. All personnel who enter the work area must sign the entry log located in the clean room, upon entry and exit.

All personnel, before entering the work area, shall read and be familiar with all posted regulations, personal protection requirements (including workplace entry and exit procedures) and emergency procedures. A sign-off sheet shall be used to acknowledge that these have been reviewed and understood by all personnel prior to entry.

All personnel shall proceed first to the clean room, remove all street clothes and put on appropriate respiratory protection (as deemed adequate for the job conditions) and launderable and/or disposal coverall, head covering and foot covering. Hard hats, eye protection and gloves shall also be utilized if required. Clean respirators and protective clothing shall be provided and utilized by each person for each separate entry into the work area.

Personnel wearing designated personal protective equipment shall proceed from the clean room through the shower room and equipment room to the main work area.

Before leaving the work area, all personnel shall remove gross contamination from the outside of respirators and protective clothing by brushing or/wet wiping procedures. (Small HEPA vacuums with brush attachments may be utilized for this purpose, however, larger machines may tear the suits.) Each person shall clean bottoms of protective footwear in the walk-off pan just prior to entering the equipment room.

Personnel shall proceed to equipment room where they remove all protective equipment except respirators. Deposit disposable (and launderable) clothing into appropriately labeled containers for disposal (and laundering).

Reusable, contaminated footwear shall be stored in the equipment room when not in use in the work area. Upon completion of abatement it shall be disposed of as asbestos contaminated waste. (Rubber boots may be decontaminated at the completion of the abatement for reuse.)

Still wearing respirators, personnel shall proceed to the shower area, clean the outside of the respirators and the exposed face area under running water prior to removal of respirator and shower and shampoo to remove residual asbestos contamination. Various types of respirators will require slight modification of these procedures. An airline respirator with HEPA filtered disconnect protection may be disconnected in the equipment room and placed into the shower. A powered air-purifying respirator facepiece will have to be disconnected from the filter/power pack assembly, which is not waterproof, upon entering the shower. Cartridges must be replaced for each new entry into the work area.

After showering and drying off, proceed to the clean room and don clean disposable (and/or launderable) clothing if there will be later re-entry into the work area or street clothes if it is the end of the work shift.

These procedures shall be posted in the clean room and equipment room.

3.1.08 Waste Container Pass-Out Procedures. Asbestos contaminated waste that has been containerized shall be transported out of the work area through the waste container passout airlock (or through the worker decontamination enclosure if a separate airlock has not be constructed).

Waste pass-out procedures shall utilize 2 teams of workers, an "inside" team and an "outside" team.

The inside team wearing appropriate protective clothing and respirators for inside the work area shall clean the outside, including bottoms, of properly labeled containers (bags, drums, or wrapped components) using HEPA vacuums and wet wiping techniques and transport them into the waste container pass-out airlock. No worker from the inside team shall further exit the work area through this airlock.

The outside team, wearing a different color protective clothing and appropriately assigned respirators, shall enter the airlock from outside the work area, enclose the drums in clean, labeled, 6-mil (0.2 mm) polyethylene bags and remove them from the airlock to the outside. No worker from the outside team shall further enter the work area through this airlock.

The exit from this airlock shall be secured to prevent unauthorized entry.

3.1.09 Training. Prior to commencement of abatement activities, all personnel who will be required to enter the work area or handle containerized asbestos containing materials must have received adequate training in accordance with this section. Special on-site training on equipment and procedures unique to this job site shall be performed as required. Training in emergency response and evacuation procedures shall be provided.

Training shall be provided by the Contractor to all employees or agents who may be required to disturb asbestos contaminated materials for abatement and auxiliary purposes and to all supervisory personnel who may be involved in planning, execution or inspection of abatement projects.

Training shall provide, at a minimum, information on the following topics:

The health hazards of asbestos including the nature of various asbestos related diseases, routes of exposure, known dose-response relationships, the synergistic relationship between asbestos exposure and cigarette smoking, latency periods for disease and health basis for standards.

The physical characteristics of asbestos including fiber size, aerodynamic properties, physical appearance and uses.

Employee personal protective equipment including the types and characteristics of respirator classes, limitations of respirator classes, limitations of respirators, proper selection, inspection, donning, use, maintenance and storage of respirators, field testing and face-piece-to face seal (positive and negative pressure fitting tests), qualitative and quantitative fit testing procedures, variations between laboratory and field fit factors, factors that affect respirator fit (e.g. facial hair), selection and use of disposable clothing, use and handling of launderable clothing, non-skid shoes, gloves, eye protection and hard hats.

Medical monitoring requirements for workers including required and recommended tests, reasons for medical monitoring and employee access to records.

Air monitoring procedures and requirements for workers including description of equipment and procedures, reasons for monitoring, types of samples and current standards with recommended changes.

Work practices for asbestos abatement including purpose, proper construction and maintenance of air-tight plastic barriers, job set-up of airlocks, worker decontamination systems and waste transfer airlocks, posting of warning signs, engineering controls electrical and ventilation system lockout, proper working techniques, waste clean-up, storage and disposal procedures.

Personal hygiene including entry and exit procedures for the work area, use of showers and prohibition of eating, drinking, smoking and chewing in the work area.

Special safety hazards that may be encountered including electrical hazards, air contaminants (CO, wetting agents, encapsulant, materials from Owner's operation), fire and explosion hazards, scaffold and ladder hazard, slippery surfaces, confined spaces, heat stress and noise.

Workshops affording both supervisory personnel and abatement workers the opportunity to see (and experience) the construction of containment barriers and decontamination facilities.

Supervisory personnel shall, in addition, receive training or contract specifications, liability insurance and bonding, legal considerations related to abatement, establishing respiratory protection medical surveillance programs, EPA, OSHA (and State) record keeping requirements, and other topics as requested by the Engineer.

Training shall be provided by individuals qualified by virtue of experience and education to discuss the topic within 12 months prior to the initiation of abatement activities. Contractor must document training by providing date of training, training entity, course outline, names, and qualifications of trainers.

3.1.10 Respiratory Protection. Respiratory protection shall be provided to workers in accordance with the submitted written respiratory protection program, which includes all items in OSHA 29 ACFR 1910.134 (b) (1-11). This program shall be posted in the clean room of the worker decontamination enclosure system.

Workers shall be provided with personally issued, individually identified (marked with waterproof designations), respirators.

The Contractor (in conjunction with an industrial hygienist) shall determine the level of respiratory protection required for asbestos activities, select an appropriate respirator type, and shall notify the Engineer of their selection. The U.S. EPA recommends that Type "C" air-supplied respirators in positive pressure or pressure demand mode with full facepieces and HEPA filtered disconnect protection be provided to all full shift asbestos abatement workers. Powered air purifying respirators equipped with HEPA filtration and full facepieces may be utilized for inspection or repair work of less than 1 hour duration.

3.1.11 Implementation Suggestions. The use of engineering controls such as negative pressure ventilation units and HEPA vacuums and good work practices such as the wetting of asbestos containing material prior to abatement (when applicable), misting the work area to help fibers settle out, removal in small sections, use of glove bags and proper clean-up and containerization all help to reduce airborne fiber levels in the work area. A properly designed air monitoring program, implemented by a qualified air sampling professional and analytical laboratory, may support the use of respiratory protective devices that provide a lower factor of protection to the workers than air supplied respirators, for some abatement activities. Safety problems associated with the use of airline systems and time and financial constraints may be reduced through the use of alternative types of respiratory protection. It is imperative, however, that adequate air monitoring of fiber levels and a well designed respiratory protection program (in accordance with 29 CFR

1910.134) be implemented. Key points of the respirator program include proper selection of respirator type and size, training of personnel in the proper inspection, donning, use, cleaning and maintenance procedures for the respirator selected including their use limitations and a good fitting and fit testing program to provide proper protection. Single use disposable respirators are not to be used during any asbestos abatement activities. Negative-pressure dual cartridge respirators shall be equipped with high efficiency filters and exhalation and inhalation valves to permit the performance of positive and negative pressure fit checks.

3.1.12 Fit Testing. Workers must perform positive and negative air pressure fit tests each time a respirator is put on, whenever the respirator design so permits. Powered air-purifying respirators shall be tested for adequate flow as specified by the manufacturer.

Workers shall be given a qualitative fit test in accordance with procedures detailed in the OSHA Lead Standard (29 CFR 1910.1025, Appendix D, Qualitative Fit Test Protocols) for all respirators to be used on this abatement project. An appropriately administered quantitative fit test may be submitted for the qualitative fit test.

Documentation of adequate respirator fit must be provided to the Contractor.

No one wearing a beard shall be permitted to don a respirator and enter the work area.

Additional respirators (minimum of 2 of each type) and training on their donning and use must be available at the work site for authorized visitors who may be required to enter the work area.

3.1.13 Protective Clothing. Disposable clothing including head, foot and full body protection shall be provided in sufficient quantities and adequate sizes for all workers and authorized visitors. Hard hats, protective eye wear, gloves, rubber boots and/or other footwear shall be provided as required for workers and authorized visitors. Safety shoes may be required for some activities.

3.2 PERFORMANCE.

3.2.01 Removal Procedures. Clean and isolate the work area in accordance with work area preparation section.

Wet all asbestos containing material with an amended water solution using equipment capable of providing a fine spray mist, in order to reduce airborne fiber concentrations when the material is disturbed. Saturate the material to the substrate, however, do not allow excessive water to accumulate in the work area. Keep all removed material wet enough to prevent fiber release until it can be containerized for disposal. If work area temperatures are below 32 degrees "F" (0 degrees C) and amended water is subject to freezing, dry removal permits and procedures must be utilized. Maintain a high humidity in the work area by misting or spraying to assist in fiber settling and reduce airborne concentrations. Wetting procedures are not equally effective on all types of asbestos containing materials, but shall none-the-less be used in all cases.

Saturated asbestos containing material shall be removed in manageable sections. Removed material should be containerized before moving to a new location for continuance of work. Surrounding areas shall be periodically sprayed and maintained in a wet condition until visible material is cleaned up.

Material removed from building structures or components shall not be dropped or thrown to the floor. Material should be removed as intact sections or components whenever possible and carefully lowered to the floor.

Containers (6-mil (0.2 mm) polyethylene bags or drums) shall be sealed when full. (Wet material can be exceedingly heavy. Double bagging of waste material usually is necessary. A determination of need for single or double bags must be made early in the abatement process and the Contractor notified.) Bags shall not be over filled. They should be securely sealed to prevent accidental opening and leakage by typing tops of bags in an overhand knot or by taping in gooseneck fashion. Do not seal bags with wire or cord. (Bags may be placed in drums for staging and transportation to landfill. Bags shall be decontaminated on exterior surfaces by wet cleaning and HEPA vacuuming before being placed in clean drums and sealed with locking ring tops.)

Large components removed intact may be wrapped in 2 layers of 6-mil (0.2 mm) polyethylene sheeting secured with tape for transport to the landfill.

Asbestos containing waste with sharp edged components (e.g. nails, screws, metal latch, tin sheeting) will tear the polyethylene bags and sheeting and shall be placed into drums for disposal.

After completion of all stripping work, surfaces from which asbestos containing materials have been removed shall be wet brushed and sponged or cleaned by some equivalent method to remove all visible residue.

Clean up shall proceed in accordance with clean up section.

After the work area has been rendered free of visible residues, a thin coat of a satisfactory encapsulating agent shall be applied to all surfaces in the work area including structural members, building components and plastic sheeting on walls, floors and covering non-removable items, to seal in non-visible residue. (Note: [1] High temperature components such as boilers and pipes may not permit the application of some encapsulant. [2] If insulation or acoustical materials are to be reapplied to the abated area, be certain that the encapsulant selected will permit good adhesion to the substrate. A small area should be tested before application.)

Special circumstances (e.g. live electrical equipment, high amosite content of material, materials previously coated with an encapsulant or paint) may prohibit the adequate use of wet methods to reduce fiber concentrations. For these situations, a dry removal may be required. Obtain special permits, different from those mentioned herein from the NESHAP enforcement agency.

3.2.02 Enclosure Procedures. Clean and isolate the work area.

Spray areas that will be disturbed during the installation of hangers or other support/framing materials for the enclosure with water containing the specified surfactant. Keep these areas damp to reduce airborne fiber concentrations.

Remove loose or hanging asbestos containing materials in accordance with the requirements.

After installation of hangers and other fixing devices and before installation of enclosure, repair damaged areas of fireproofing/thermal insulation materials as required using a non-asbestos containing replacement material in accordance with manufacturer's recommendations.

Specify enclosure procedures and include the following requirements:

> Use hand tools equipped with HEPA filtered local exhaust ventilation to drill, cut into or otherwise disturb asbestos containing materials during the installation of support systems for the enclosures. (Alternatively, these areas of material could be removed prior to installation of supports.)
>
> Use materials that are impact resistant and that will provide an air tight barrier once construction is complete.
>
> Lower utilities as necessary and reinstall in a manner, which permits proper utilization and does not disturb the integrity of the enclosures. Utility maintenance should not require the enclose to be opened or disturbed. (If it does, an alternative abatement strategy is indicated.)
>
> Enclosed asbestos containing materials shall be designated appropriately (Specify format--sign, label, color code and frequency/location of indicators) in order to warn building maintenance personnel in the event that they are required to disturb the enclosure.

3.2.03 Clean-Up Procedures. Remove and containerize all visible accumulations of asbestos containing material and asbestos contaminated debris utilizing rubber dust pans and rubber squeegees to move material around. Do not use metal shovels to pick up or move accumulated waste. Special care shall be taken to minimize damage to floor sheeting.

Wet clean all surfaces in the work area using rags, mops and sponges as appropriate. (Note: Some HEPA vacuums might not be wet-dry vacuums. To pick up excess water and gross wet debris, a wet-dry shop vacuum may be used. This will be contaminated and require cleaning prior to removal from the work area.)

Remove the cleaned outer layer of plastic sheeting from walls and floors. Windows, doors, HVAC system vents and all other openings shall remain sealed. The negative pressure ventilation units shall remain in continuous operation. Decontamination enclosure systems shall remain in place and be utilized.

After cleaning the work area, wait at least 24 hours to allow fibers to settle and HEPA vacuum and wet clean all objects and surfaces in the work area again.

Remove all containerized waste from the work area and waste container pass-out airlock. Decontaminate all tools and equipment and remove at the appropriate time in the cleaning sequence. Inspect the work area for visible residue. If any accumulation of residue is observed, it will be assumed to be asbestos and the 24 hour settling period/cleaning cycle repeated.

The work area shall be cleaned until it is in compliance with State and Local requirements and any more stringent criteria agreed upon by the Contractor and the Engineer prior to initiation of abatement activities (criteria should be in the form of visual inspections and airborne fiber concentrations). Additional cleaning cycles shall be provided, as necessary, at no cost to the Owner until these criteria have been met.

Following the satisfactory completion of clearance air monitoring, remaining barriers may be removed and properly disposed of. A final visual inspection by the Engineer shall insure that no contamination remains in the work area. Unsatisfactory conditions may require additional cleaning and air monitoring.

3.2.04 Disposal Procedures. As the work progresses, to prevent exceeding available storage capacity on site, sealed and labeled containers of asbestos containing waste shall be removed and transported to the prearranged disposal location.

Disposal must occur at an authorized site in accordance with regulatory requirements of NESHAP and applicable State and Local guidelines and regulations.

All dump receipts, trip tickets, and transportation manifests or other documentation of disposal shall be delivered to the Contractor for his records. A recommended record keeping format utilizes a chain of custody form which includes the names and addresses of the Owner, Contractor, pickup site, and disposal site, the estimated quantity of the asbestos waste and the type of containers used. The form should be signed by the Owner, the Contractor, and the Disposal Site Operator, as the responsibility for the material changes hands. If a separate hauler is employed, his name, address, telephone number and signature should also appear on the form.

3.2.05 Transportation of Landfill. Once drums, bags and wrapped components have been removed from the work area, they shall be loaded into an enclosed truck for transportation.

When moving containers, utilize hand trucks, carts and proper lifting techniques to avoid back injuries. Trucks with lift gates are helpful for raising drums during trucks' loading.

The enclosed cargo area of the truck shall be free of debris and lined with 6-mil polyethylene sheeting to prevent contamination from leaking or spilled containers. Floor sheeting shall be installed first and extended up the sidewalls. Wall sheeting shall be overlapped and taped into place.

Drums shall be placed on level surfaces in the cargo area and packed tightly together to prevent shifting and tipping. Large structural components shall be secured to prevent shifting and bags placed on top. Do not throw containers into truck cargo area.

Personnel loading asbestos containing waste shall be protected by disposable clothing including head, body and foot protection and at a minimum, half-facepiece, air-purifying, dual cartridge respirators equipped with high efficiency filters.

Any debris or residue observed on containers or surfaces outside of the work area resulting from clean-up or disposal activities shall be immediately cleaned-up using HEPA filtered vacuum equipment and/or wet methods as appropriate.

Large metal dumpsters are sometimes used for asbestos waste disposal. These should have doors or tops that can be closed and locked to prevent vandalism or other disturbance of the bagged asbestos debris and wind dispersion of asbestos fibers. Unbagged material shall not be placed in these containers, nor shall be used for non-asbestos waste. Bags shall be placed, not thrown, into these containers to avoid splitting.

3.2.06 Disposal at the Landfill. Upon reaching the landfill, trucks are to approach the dump location as closely as possible for unloading of the asbestos containing waste.

Bags, drums and components shall be inspected as they are off-loaded at the disposal site. Material in damaged containers shall be repacked in empty drums or bags as necessary.

Waste containers shall be placed on the ground at the disposal site, not pushed or thrown out of trucks (weight of wet material could rupture containers).

Personnel off-loading containers at the disposal site shall wear protective equipment consisting of disposable head, body and foot protection and, at a minimum, half-facepiece, air-purifying, dual cartridge respirators equipped with high efficiency filters.

Following the removal of all containerized waste, the truck cargo area shall be decontaminated using HEPA vacuums and/or wet methods to meet the no visible residue criteria. Polyethylene sheeting shall be removed and discarded along with contaminated cleaning materials and protective clothing in bags or drums at the disposal site.

If landfill personnel have not been provided with personal protective equipment for the compaction operation by the landfill operator, Contractor shall supply protective clothing and respiratory protection for the duration of this operation

3.2.07 Reestablishment of the Work Area. Reestablishment of the work area shall only occur following the completion of clean-up procedures and after clearance air monitoring has been performed and documented to the satisfaction of the Engineer.

Polyethylene barriers shall be removed from walls and floors at this time, maintaining decontamination enclosure systems and barriers over doors, windows, etc. as required.

The Contractor and Engineer shall visually inspect the work area for any remaining visible residue. Evidence of contamination will necessitate additional cleaning.

Additional air monitoring shall be performed if additional clean-up is necessary.

Following satisfactory clearance of the work area, remaining polyethylene barriers may be removed and disposed of as asbestos contaminated waste.

At the discretion of the Contractor, mandatory requirements for personal protective equipment may be waived following the removal of all barriers.

Resecure mounted objects removed from their former positions during area preparation activities.

Relocate objects that were removed to temporary locations back to their original positions.

Reestablish HVAC, mechanical and electrical systems in proper working order. Remove contaminated HVAC system filters and dispose of as asbestos contaminated waste. Decontaminate filter assembly using HEPA vacuums and wet cleaning techniques. Install new filters in HVAC systems. Dispose of old filters.

Repair all areas of damage that occurred as a result of abatement activities.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Testing. Following the completion of clean-up operations, the Contractor shall notify the Engineer that the work area is ready for clearance air monitoring.

The Contractor shall then arrange for an Air Monitoring Professional to sample the air in the work area for airborne fiber concentrations.

The use of Transmission Electron Microscopy (TEM) is highly recommended for clearance air monitoring. Availability of this analytical service may be limited, however, and turn around time for sample analysis may be significantly longer than the NIOSH methods. The air sampling shall otherwise be conducted using sampling pumps calibrated at a flow rate of at least 2 and not more than 0.14 cu. ft. (4 liters) per minute using collection media and procedures in accordance with NIOSH Standard Analytical Method P&CAM 239 or 7400, as available. Air volumes shall be sufficient to provide reliable results down to a concentration of 0.01 fibers per cubic centimeter of air (f/cc) or lower. Minimum air volumes of 105.9 cu. ft. (3000 liters) shall be collected for P&CAM and 35.3 cu. ft. (1000 liters) for method 7400. Volume requirements for electron microscope methods should be discussed with the analytical laboratory.)

The number of samples that are required and the specific locations where they shall be taken should be established by the Contractor in conjunction with an industrial hygienist and the Engineer notified before abatement activity begins.

Aggressive sampling shall be performed with portable fans circulating air in the work area to simulate actual use conditions. Negative pressure ventilation units shall not be utilized for this purpose.

All samples at all locations shall indicate concentrations of airborne fibers less than 0.16 f/in^3 (0.01 f/cm^3) for release of the work area.

Areas exceeding this level shall be recleaned and retested until satisfactory levels are obtained.

3.3.02 Implementation Suggestions. The following is excerpted from A Review of the Scientific Basis for EPA: School Asbestos Hazard Program with Recommendations to State Health Officials. Published by the Centers for Disease Control in October, 1984.)

When air samples are collected after an asbestos abatement, the "action level" should conform with a policy of lowest feasible level. The concept of an environmental "action level" is not the same as that of a permissible exposure limit that is precisely monitored for compliance with regulatory standards. As used here it is consistent with a policy of recommending that asbestos exposures be reduced to the lowest feasible level. It is readily measured by the NIOSH #7400 for asbestos in air; and it should be helpful to those who must make risk management decisions when the general public is potentially exposed to asbestos.

An "action level" of 0.16 f/in^3 (0.01 f/cm^3) may be useful as a guideline for monitoring a building with potentially hazardous asbestos surfaces, as part of a comprehensive program or during abatement work, maintenance, etc. It is not recommended "occupancy" or "safe" level.

Using the NIOSH Method #7400 including modified rules for counting only fibers with aspect ratios of 5:1 or more in a 35.3 cu. ft. (1,000 liter) air sample will permit detection and quantification of about 0.16 f/in^3 (0.01 f/cm^3) if a coefficient of variation of 25% is considered acceptable for risk-management decisions. This variability is reasonable, since the conversion factor used to convert mass concentration to fiber concentrations in environmental risk assessment has such a large uncertainty factor.

3.3.03 Medical Monitoring. Medical monitoring must be provided by the Contractor to any employee or agent that may be exposed to asbestos in excess of background levels during any phase of the abatement project. (Due to the synergistic effects between smoking and asbestos exposure, it is highly recommended that only non-smokers be employed in positions which may require them to enter asbestos contaminated atmospheres.)

Medical monitoring shall include at a minimum:

A work/medical history to elicit symptomatology of respiratory disease.

A chest x-ray (posterior-anterior, 14 x 13 inches (35.6 x 33.0 cm)) evaluated by a Certified B-reader.

A pulmonary function test, including forced vital capacity (FVC) and forced expiratory volume at one second (FEV)1, administered and interpreted by a Certified Pulmonary Specialist.

Employees shall be given an opportunity to be evaluated by a physician to determine their capability to work safely while breathing through the added resistance of a respirator.

Examining physicians shall be aware of the nature of respiratory protective devices and their contributions to breathing resistance. They shall also be informed of the specific types of respirators the employees shall be required to wear and the work he will be required to perform, as well as special workplace conditions such as high temperatures, high humidity, and chemical contaminants to which he may be exposed.

3.3.04 Asbestos Project Manager. The Asbestos Project Manager shall be the Contractor or a designated representative paid by the Contractor. Also known as a Competent Person this person could be an administrator, architect, engineer, industrial hygienist or other individual[s] certified by the State of Michigan for safe methods of asbestos removal.

The Asbestos Project Manager shall be able to demonstrate through special education, training, skills, knowledge or experience satisfactory to the Engineer to indicate the ability to carry out the following activities as required:

Assist in decision making regarding selection of procedures.

Enforce contract specifications.

Tour work area with the sub-contractors and agree on pre-abatement conditions of the work area.

Inspect and sign off on barriers and decontamination enclosure systems.

Observe activities at all times during the course of abatement.

Meet with the sub-contractors daily to review work progress and solve problems or adjust procedures as appropriate.

Perform bulk material or air sampling and all workplace inspection and clearance inspections for the Owner.

Report on abatement to the Engineer.

Request, review and maintain Contractor submittals.

Provide training and/or respirator fit testing to personnel.

The Asbestos Project Manager shall have the authority to stop any job activities if they are not being performed in accordance with applicable regulations or guidelines or the requirements of this specification. These will be reported to the Engineer with description of activity, reason for stopping it and alternatives for correcting the problem.

The Asbestos Project Manager shall be covered by adequate liability insurance to protect against errors and omission in the performance of support activities.

3.3.05 Air Sampling Professional (ASP). The Air Sampling Professional shall conduct all air sampling in accordance with the NIOSH Standard Analytical Method for Asbestos in Air P&CAM 239 and/or Method 7400 or other acceptable methods as otherwise agreed upon.

The following schedule shall be utilized for air sampling during the project (in addition to OSHA compliance monitoring):

Pre-abatement sampling: A sufficient number of air samples shall be collected prior to the start of abatement activities in order to determine prevalent airborne concentrations. Samples should be taken both inside and outside of the work area and buildings to establish existing levels under normal activity conditions.

Sampling during the abatement project: The following schedule of samples shall be required on a daily basis, once abatement activities begin and are recommended minimums. The size of the abatement activity will impact on the number of samples necessary to adequately monitor the Contractor's activities. Decisions on the number of samples should be made with the advice of the Air Sampling Professional:

Two Area Samples (inside the work area).

Two Personal Samples (inside the work area).

Two Area Samples (outside the work area in uncontaminated areas of the building.

One of these shall be at the entrance to the worker decontamination enclosure.)

One Area Sample (outside the building).

One Area Sample (at the exhaust of negative pressure ventilation equipment). Samples shall be collected at a sampling rate of 0.07 cu. ft./min. (2 liters/min). A minimum acceptable air volume is 17.0 cu. ft. (480 liters).

Post-Abatement (clearance) air sampling shall be conducted following the cleaning phase of work, once the no visible residue criterion has been met. A sufficient number of samples shall be collected aggressively (with portable fans circulating air in the work area to simulate actual use conditions) to determine post-abatement air concentrations. For an adequate volume of air concentration it is required that an adequate volume of air provides, accuracy to 0.16 fibers/in^3 (0.01 fibers/cm^3)

The Air Sampling Professional shall be experienced and knowledgeable about the methods for asbestos air sampling and be able to select representative numbers and locations of samples.

The Air Sampling Professional shall have adequate liability insurance to protect against errors and omissions in the performance of support activities.

3.3.06 Laboratory Services. Laboratory utilized for analyzing air samples by NIOSH shall be satisfactory participants in the NIOSH Proficiency Analytical Testing (PAT) program asbestos analysis.

Laboratories used for bulk material identification shall be satisfactory participants in the EPA quality assurance program for bulk asbestos analysis.

The period of time permitted between the collection of air samples and the availability of results shall be less than twenty-four (24) hours for samples collecting during abatement activities. Time tables for results of pre-abatement and clearance air samples shall be established with the Engineer. On-site analytical capabilities are preferred for immediate results of sampling. This provides the Engineer with a timely review of Contractor performance and a more rapid awareness of hazardous exposure conditions which can be corrected. This service may not be readily available, however, real-time monitoring instruments provide some support in this matter as long as their limitations are clearly understood and the Contractor and Engineer agree in advance on how the results are to be used. These devices which do not meet current OSHA monitoring requirements should not be used for sampling during the abatement project.

End of Section

SECTION 02084

MODIFICATIONS TO EXISTING STRUCTURES, PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE. This section includes all work necessary to modify, alter or abandon existing building components, drainage structures, miscellaneous chambers and facilities, piping, equipment and associated appurtenances.

Furnish all materials, labor and equipment, as required for the work as shown and as specified herein.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C33 - Concrete Aggregates

ASTM C150 - Portland Cement

MDOT Standard Specifications for Construction, Current Edition

Detroit City Engineering Division Standard Specifications for Paving and Related Construction, October 1999

1.3 QUALITY ASSURANCE. Accomplish modifications of existing construction, utilities, and appurtenances without damaging integrity of existing structures, equipment, and appurtenances that are to remain.

The Contractor shall assume full responsibility for any and all damages resulting from his work. Repair or replace items that are damaged at no additional compensation and to condition at least equal to that which existed prior to start of work.

Provide protection of persons and property throughout progress of work. Proceed in such a manner as to minimize spread of dust and flying particles and to provide safe working conditions for personnel.

Obtain permission from Engineer before abandoning or removing any existing structures, materials, equipment and appurtenances.

Arrange with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to work.

Perform all operations in accordance with applicable regulations of the City of Detroit, State of Michigan Department of Health, State of Michigan OSHA, and Federal Government.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit a detailed plan for all of the work required, describing proposed sequence, methods, and equipment for modifying, altering or abandoning of each building, structure or piping and equipment prior to any work commencing. Provide mix designs for all cementitious materials.

1.4.02 Samples. Provide samples of all materials.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Protect adjacent structures, utilities, equipment, and property during execution of the work. Costs associated with replacing damaged elements and items shall be borne by the Contractor.

Where work occurs in a confined space, the Contractor shall monitor the atmosphere in accordance with federal, state and local ordinances, rules and regulations. Provide equipment for dewatering work spaces.

All work done in street and road right of ways in Detroit shall comply with the current City Engineering Division specifications for Paving and Related Construction and the MDOT Standard Specification for Construction.

2.2 MATERIALS.

2.2.01 Cement Stabilized Fly Ash. Filling voids in abandoned large sewers or tunnels: Cement stabilized fly ash shall generally be used.

At the option of the contractor, the cement stabilized fly ash mixture filling may include aggregate. Cement content shall be 2 percent by weight.

2.2.02 Bulkheads. Bulkheads shall be vented and designed to retain the full fluid head of cement stabilized fly ash and/or other materials acting on the bulkhead. If bulkheads are to remain in place, biodegradable material such as wood will not be permitted. Vent holes shall be filled after entire stretch of tunnel, sewer, conduit or structures have been filled. Brick bulkheads, as required, shall be built of common brick.

The surface of contact of the sewer wall with the bulkhead shall be roughened by bush-hammering or chiseling and then cleaned just prior to the bulkhead construction. Such bulkheads shall be vertical, of the thickness shown on the Plans, with alternate header and stretcher courses laid in mortar in the manner specified for “Manholes”. The joints shall be 5/8 inch (16 mm) thick and finished flush.

Removal of bulkheads shall be done in a careful manner that will avoid damage to the sewer. The surface of contact of the sewer wall with the bulkhead shall be cleaned of all brick and mortar and the wall surface left as smooth as possible without mortar patching. The materials from the removed bulkhead shall be promptly removed from the sewer and not left to accumulate.

PART 3 - EXECUTION

3.1 PREPARATION. Dewater work areas subject to standing or flowing water. Remove all standing or flowing water within structures being backfilled.

Provide, erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor’s employees and existing improvements to remain.

Erect and maintain weatherproof enclosures for exterior openings. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Owner occupancy. Prevent movement of structures, piping, and appurtenances. Provide temporary bracing and shoring as required.

Notify affected utility companies before starting work and comply with their requirements. Cap or plug pipes and other conduits abandoned due to demolition as indicated on Drawings or as specified. Mark location and termination of utilities.

Blasting will not be permitted. Demolition work shall be performed in accordance with all applicable laws and ordinances. Saw cut existing sewers at all connections so that the edges are straight and not ragged. Plug all leaks within the structures being backfilled prior to backfilling.

3.2 INSTALLATION.

3.2.01 Sewer and Structure Tap. Where connections are to be made from the side into an existing 4 feet (1.2 m) or larger sewer or to structures, an opening shall be cut or chipped in the sewer or structure sufficiently large to permit 3 inches (7.5 cm) of non-shrink mortar to be placed around the entering pipe. The mortar shall be used for setting the pipe, and the mortar shall be pointed up smooth and flush with the inner wall of the sewer or structure.

The pipe passing through sewer or structure walls shall be cut at the end to conform to the shape of and be flush with the inside wall. The pipe entering a sewer shall point downstream, as shown on the Drawings. On the outside of the sewer or structure wall, the entering pipe shall be encased in 6 inches (15.0 cm) of Grade “A” concrete for a minimum length of 12 inches (30.0 cm). In addition, Grade “C” or Grade “A” concrete shall be placed as a bedding to undisturbed earth.

Where connections are made from the side into a sewer 18 inches (45.0 cm) or smaller, if the outside diameter of the tap is greater than one-half the diameter of the sewer being tapped, a wye shall be sprung into the existing line and the entire wye encased with 6 inches (15.0 cm) of concrete beyond the joint at each end where it joins the existing sewer.

Saddles encased in concrete shall be used on all other connections. The concrete must extend over the top of the pipe and down to the spring line on the opposite side.

While making the tap, care shall be taken to prevent concrete or debris from entering the existing sewer or structure. Any concrete or debris that does fall into the existing sewer or structure shall be removed.

3.2.02 Sewer Manhole Adjustment And Cone Reconstruction. Existing manholes that are to remain shall have their tops adjusted to the new required grades and cross-sections.

The existing frame and cover shall be carefully removed and the upper portion of the existing manhole structure raised or lowered as required. The frame and cover shall then be set on the adjusted structure to fit the required new grade and cross section. All work in connection therewith shall be done according to the applicable provisions for new manholes. Where pavements are called for to be removed and manholes remaining in service are to be adjusted, a 5 foot by 5 foot by 6 inches (1.5 meter x 1.5 meter x 15.0 cm) Grade “A” concrete slab shall be constructed around the manhole.

Existing sewer manhole frames or covers, or both, which are warped, broken, or any non-standard casting or concrete, as determined by the Engineer, shall be furnished and installed by the Contractor.

3.2.03 Water Gate Manhole And Stop Box Adjustment. The tops of existing water gate manholes and stop boxes shall be adjusted to the new required grades and cross-sections in the same manner as specified for sewer manholes.
Should existing castings require replacement, such castings shall be exchanged, at no cost, by the Contractor for new castings at the D.W.S.D. Central Service Facilities – Materials Management, 6425 Huber Street, between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday. The Engineer shall furnish a written order authorizing the casting exchange.

3.2.04 Sewer Manhole Abandonment. Existing sewer manholes, when so indicated on the Plans, shall be abandoned. The casting shall first be removed, the manhole cone demolished and removed, the sewer inlets and outlets plugged with concrete, and the manhole backfilled in the same manner as specified for a sewer trench, or the manhole completely filled with Grade “C” concrete.

Any sewers that are to remain in use shall have a connecting pipe placed between inlet and outlet, properly connected. During this construction, satisfactory bypass service shall be maintained.

All salvageable castings shall become the property of the Contractor and shall be promptly removed from the job site.

3.2.05 Catch Basin Adjustment. Existing catch basins that are to remain shall have their tops adjusted, when so indicated on the Plans, to the new required grades and cross sections.

For catch basins that are within the paved area, the standard flat grade and frame shall be used.

For catch basins that are outside the paved area, the standard flat grate or dome grate with appropriate frame, or pyramid cover, shall be used, as directed by the Engineer.

New castings shall be furnished and installed for all adjusted catch basins except when salvage castings are available and their use authorized by the Engineer.

When the existing catch basin is a 12 inch (30.0 m), L-type, without trap, the entire catch basin shall be removed and replaced with a new standard catch basin. Should field conditions prevent replacement, the construction shall be as directed by the Engineer, with payment being made as extra work.

Where pavements are called for to be removed and catch basins remaining in service are to be adjusted, a 5 foot by 5 foot by 6 inches (1.5 meter by 1.5 meter by 15.0 cm) Grade “A” concrete slab shall be constructed around the catch basin.

3.2.06 Catch Basin Abandonment. Existing catch basins, when so indicated on the Plans, shall be abandoned. The catch basin shall be removed, the sewer outlet plugged with concrete, and the resulting hole backfilled as specified for a sewer trench, or the catch basin filled completely with Grade “C” concrete.

When special abandonment is called for in the Proposal and at locations shown on the Plans, the catch basin line shall be plugged at the lateral sewer as detailed on the Standard Plans. This special abandonment shall be used in site clearance and urban areas where the lateral sewer is remaining in service. The catch basin shall be either removed, the sewer outlet plugged with concrete, and the resulting hole backfilled as specified for a sewer trench, or the catch basin completely filled with Grade “C” concrete as directed by the Engineer.

Existing castings shall be considered as salvaged castings.

Salvaged castings not suitable for use and not required for catch basins to be adjusted in the same contract, shall become the Contractor’s property and shall be promptly removed from the job site.

3.2.07 Backfilling Abandoned Sewers. The backfill material for abandoned sewers shall be Grade “C” concrete or grout composed of two parts sand to one part cement or variations thereof as may be approved by the Engineer.

Backfill concrete shall be deposited through drop pipes placed over the abandoned sewer and at locations approved by the Engineer.

Drop-pipe holes shall be spaced at intervals that will ensure the proper and complete filling of the sewer.

All drop holes shall be sleeved for their entire length with a metal casing. The casing shall extend completely through the wall of the sewer.

The drop-pipe shall be fitted with suitable and sufficient baffles to ensure the re-mixing of the concrete rather than a separation of the materials.

The size of the drop-pipe shall be adequate for the placing of the concrete mix.

When the drop holes are no longer needed and the Engineer orders their abandonment, the castings shall be removed so that adjacent structures, utilities, and pavement will not be damaged. The hole shall then be filled with a three (3) bag concrete mix to within 5 feet (1.5 meters) of the surface. The upper portion of the hole shall be filled with compacted sand or sand-gravel and the surface replaced in kind to that originally found to the satisfaction of the Engineer.

Grout shall be placed under a pressure adequate to fill completely the abandoned portion of the sewer. However, grout pressures shall not be so high as to cause leakage from the sewer and the filling of adjacent sewers, utilities and basements.

3.2.08 Salvaged Castings. The metal frames, covers, and grates on existing manholes and catch basins that are to be reused shall be carefully removed to prevent damage.

Any reusable casting damaged by the Contractor shall be replaced with a new casting without additional cost to the City.

All salvaged castings that are not to be used on the work shall become the property of the Contractor and shall be promptly removed from the job site.

3.2.09 Public Lighting Department (P.L.D.) Manhole and Handhole Adjustment. The tops of existing P.L.D. manholes and handholes shall be adjusted to the new required grades and cross-sections as specified for sewer manholes.

If adjusting the frame and cover to the proposed grade requires adjustment of the manhole or handhole roof, the Contractor shall notify the P.L.D. The work involved in the adjustment of the roof of the structure and the adjustment of the frame and cover to the new pavement surface will be performed by the P.L.D. at no cost to the Contractor.

Should existing castings require replacement, such castings shall be exchanged, at no cost, by the Contractor for new castings at the P.L.D. Warehouse, at 9449 Grinnell Street, between the hours of 8:30 a.m. and 4:00 p.m., Monday through Friday. The Engineer shall furnish a written order authorizing the exchange of castings.

3.2.10 Force Main Abandonment. Submit plan for abandonment of Force Main. Abandon Force Main and related structures as detailed on the drawings.

3.2.11 Salvage. Materials equipment and appurtenances scheduled for salvage and delivery to DWSD shall be carefully removed and delivered to DWSD in accordance with the schedule listed in the drawings.

Materials, equipment and appurtenances removed, that are not designed for relocation, or salvage and delivery to DWSD become property of Contractor and shall be hauled from site and disposed of at no additional compensation.

End of Section

SECTION 02085 - SUPPLEMENTAL

LEAD BASED PAINT REMOVAL

PART 1-GENERAL

1.1 SCOPE OF WORK.

This section includes requirements for the removal and disposal of lead-based paint from affected surfaces, including provision of independent third party testing and clean-up inspection services.

1.2 RELATED WORK.

Divisions 0 and 1, as applicable.

Section 02050 –Demolition

Section 02075 – Hazardous and Toxic Materials Remediation

Section 02080 – Asbestos Removal

1.3 REFERENCES.

1.3.01 Code of Federal Regulations:

29 CFR 1910, “Occupational Safety and Health Standards:” (General Industry Standards).

29 CFR 1910.134, “Respiratory Protection”.

29 CFR 1910.1025, “Lead”.

29 CFR 1910.1200, “Hazard Communication”

29 CFR 1926, “Safety and Health Regulations for Construction” (Construction Industry Standards).

40 CFR 50, “National Primary and Secondary Ambient Air Quality Standards”.

40 CFR 60, “Standards of Performance for New Stationary Sources”.

40 CFR 117, “Determination of Reportable Quantities for Hazardous Substances”.

40 CFR 122, “EPA Administered Permit Program: The National Pollutant Discharge Elimination System.”

40 CFR 261, “Identification and Listing of Hazardous Waste”.

40 CFR 263, “Standards Applicable to Transporters of Hazardous Waste”.

40 CFR 265, “Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities”.

40 CFR 268, “Land Disposal Restrictions”.

40 CFR 300, “National Oil and Hazardous Substances Pollution Contingency Plan”.

40 DFR 302, “Designation, Reportable Quantities and Notification”.

1.3.02 State of Michigan Regulations:

MCLA 299.9101 – 299.11107 “Michigan Hazardous Waste Management”.

National Institute for Occupational Health and Safety: NIOSH Method 7082, “Sampling Airborne Particulates for Lead”.

1.3.03 American Society for Testing and Materials:

ASTM D3335, “Test Method for Low Concentrations for Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy”.

1.3.04 EPA (Environmental Protection Agency) Publications:

SW-846, Test Methods for Evaluating Solid Waste – Physical/Chemical Methods.

EPA Method 3050, “Acid Digestion of Sediments, Sludges and Soils”.

SSPC (Steel Structures Painting Council): Guide 61 (CON), Guide for Containing Debris Generated During Paint Removal Operations.

“Industrial Lead Paint Removal Handbook“, 2nd Edition, Kenneth A. Trimber.

Test reports identified in Section 00210.

1.4 DEFINITIONS.

Lead-Containing Paint: Paint containing a minimum of 1.0 mg/cm2 (milligram per square centimeters) lead or containing 0.5 percent lead by weight as determined by on-site testing of the coating with a portable X-ray fluorescence (XRF) detector, or through laboratory testing in accordance with ASTM D3335.

1.4.01 Hazardous Waste: Lead paint debris is classified as hazardous due to the characteristic of toxicity, if after testing by Toxicity Characteristic Leaching Procedures

(TCLP), the leachate contains any of the elements in the concentrations listed below (or greater):

Arsenic	5 ppm
Barium	100 ppm
Cadmium	1 ppm
Chromium	5 ppm
Lead	5 ppm
Mercury	0.2 ppm
Selenium	1 ppm
Silver	5 ppm

Note: Other Elements can cause a material to be hazardous as defined in 40 CFR 261 and must be taken into consideration. The list above includes only those elements typically associated with paint solids. If chemical strippers are used, the debris may be hazardous waste, due to corrositivity, if the pH is less than or equal to 2 or greater than or equal to 12.5.

Generator: The facility Owner or Operator or person who first creates or produces the hazardous waste.

Large Quantity Generator: Generates over 2,200 pounds (1,000 kilograms) of hazardous waste or 2.2 pounds of acutely hazardous waste per month or stores more than 13,200 pounds (6,000 kilograms) of waste or more than 2.2 pounds of acutely hazardous waste at the site at any one time.

Small Quantity Generator: Generates more than 220 pounds (100 kilograms), but less than 2,200 pounds (1000 kilograms) of hazardous waste per month and accumulates less than 13,200 pounds (6,000 kilograms) at any one time.

Conditionally Exempt Small Quantity Generator: Generates less than 220 pounds (100 kilograms) of hazardous waste per month, and accumulates no more than 2,200 pounds (1,000 kilograms) of hazardous waste at any time.

Containment and Ventilation Systems: Includes the containment structure (i.e. containment walls, floor, supporting structure, entryways); ventilation system (i.e. and input and exhaust); and dust collection.

Milligram (mg): A milligram is 1/1,000 of a gram.

Microgram (ug): A microgram is 1/1,000,000 or a gram of 1/1,000 of a milligram.

1.5 SUBMITTALS.

1.5.01 Lead Abatement Work Plan: A minimum of 30 days prior to beginning work provide a written plan for the methods to be employed for surface preparation, containment and ventilation, and collection of debris. When designing the system, the Contractor shall recognize the load bearing capacity and integrity of the structure to be abated. The Contractor shall have the containment and ventilation plan reviewed by a Professional Engineer and submit drawings for review. In addition the Work Plan shall contain the following:

Name and address of licensed abatement contractor to undertake the Work.

Site specific Health and Safety Plan.

Site specific Lead Abatement Plan, including quantities to be removed, and abatement contractor’s policies and procedures relating to lead abatement work.

Employee Training Accreditations/Certifications and Physician Clearances, including accreditation certificate from the State of Michigan of Abatement Contractor’s Project Designer.

Lead Abatement License.

Documentation of Respiratory Equipment Fit Tests.

Manufacturer’s information for materials and equipment to be utilized in the work, including Material Safety Data Sheets (MSDS).

Documentation of abatement contractor’s insurance (certificates).

Credentials of independent, third party consultant who will provide testing and clean-up inspection services as specified herein.

Programs for the Protection of the Ambient Air and Water: Submit written testing and evaluation that will be used to confirm that the work does not violate Federal, State and Local regulations. Refer to Item 1.07 for acceptance criteria.

1.5.02 Ambient Air Quality: Submit a written program for air monitoring at the project site to confirm that fugitive dust emissions do not exceed specified criteria. The following shall be addressed:

Particulate Matter: Monitor emissions of particulate matter equal to or greater than 10 micrometers (PM 10) in aerodynamic size in accordance with 40 DFR 50. Include the type and number of samplers to be used, their proposed locations, provisions for background monitoring, and the duration of testing.

Visible Emissions: Submit a written plan for the observations that will be made to verify that the visible emissions criteria of this specification are not exceeded.

Total Suspended Particulate (TSP) Lead: Submit a program for the analysis of airborne lead emissions in accordance with 40 CFR 50. Include the type and number of samplers to be used, their proposed locations, provisions for background monitoring and duration of testing.

Lead Emissions Using Personal Monitors: Submit a program that identifies the proposed monitoring sites for the use of personal monitors in accordance with NIOSH Method 7082. The duration of monitoring, provisions for background monitoring, laboratory qualifications, and evaluation procedures to be employed shall be included.

1.5.03 Water Analysis: Submit a written program for verification of the following:

National Pollutant Discharge Elimination system (NPDES) Permit: If waste water will be discharged to sewers or surface water, obtain an NPDES permit for the work in accordance with 40 CFR 122, and that its requirements will be strictly followed.

Reportable Releases: Prepare a program for reporting releases of lead into the water in accordance with 40 CFR 117.

Water and Sediment Analysis: Outline the sampling and testing protocol proposed for the pre-job and post-job analysis of lead in the water and sediment, and provide the qualifications of testing laboratory to be used.

1.5.04 Handling, Disposal and Analysis of Debris Criteria: Submit the following:

Handling and Site Storage: A written plan that addresses the handling and site storage of lead-containing debris in accordance with the requirements of 40 CFR 262 and 40 CFR 265. The Contractor shall confirm that an EPA identification number shall be obtained if one has not already been assigned to the facility, that proper manifesting of the waste shall be addressed, and that all site storage limitations, including the time of storage, container requirements, contingency plan, and personnel training, shall be observed.

Sampling and Testing of Debris: Written procedures that will be followed for the sampling and testing of debris to determine if it is hazardous waste. The sampling procedure shall be in accordance with the requirements of SW 846, with the testing accomplished by TCLP, defined in Appendix II of 40 CFR 261. The program shall include the name of the testing laboratory to be utilized.

Transportation: Written confirmation that proper transportation of the debris shall be accomplished in accordance with the requirements of 40 CFR 263. The name of the transporter shall be included.

Disposal: Written confirmation that the debris will be treated and disposed of in accordance with the requirements of 40 CFR 264 and 40 CFR 268. The program shall provide assurance that the debris is handled properly from cradle to grave, and include the necessary notifications and certifications on shipments, provide the name of the disposal facility, and include a schedule for the submittal of the completed manifests.

Clearance Testing: The Contractor will provide written programs for the decontamination for reusable items prior to removal from the project site, or for the proper testing and disposal of the materials if decontamination is not possible or desirable.

The submitted Work Plan shall address the criteria outlined in items 1.06, 1.07, 108 and 1.09.

1.5.05 <u>Prior to commencing abatement work in any area or sub-area, if the removal will not be prosecuted continuously, the Contractor shall provide ten (10) days notice. The notice shall include the following information</u>:

Construction contract number and title.

Name of general contractor, general contractor’s superintendent and on-site telephone number.

Name of abatement contractor, abatement contractor’s superintendent and on-site telephone number.

Exact location of abatement work and estimated quantities involved.

Estimated dates and times of commencement and completion.

Date of submittal of Abatement Work Plan.

Copies of any updated notifications to regulatory agencies.

1.5.06 <u>The following shall be submitted on a weekly basis while abatement work is in process</u>:

Updates of Respiratory Fit Tests, if applicable.

Monitoring equipment calibration logs.

Daily logs of work completed.

Daily logs of employees conducting the abatement.

Environmental monitoring results.

Disposal manifests, if removed material is characterized as a hazardous waste and disposal occurs within the reporting period. The name, address and identification number of the licensed transporter/disposer shall be provided.

1.5.07 The following shall be provided prior to re-occupancy of an abated area:

Certification of Visual Inspection and Authorization for Re-Occupancy as provided by an independent, third party consultant (see Items 3.05 and 3.06).

Upon completion of the abatement submit the abatement project records specified in Item 1.10.

1.6 CRITERIA FOR CONTAINMENT SYSTEMS.

Design a containment system for the work area to control environmental emissions according to the criteria listed in Item 1.07 and control working environment within containment according to the criteria listed in Item 1.08.

Thoroughly examine the structure to be prepared to verify its ability to support a containment system, including the wind loads, if any that can be imparted by such a system. Submit containment drawings in accordance with the requirements of Item 1.05.

1.7 CRITERIA FOR CONTROL OF ENVIRONMENTAL EMISSIONS.

1.7.01 Ambient Air Quality – Particulate Matter and Visible Emissions: Monitor and control ambient air particle matter and visible emissions in accordance with the following criteria:

Ambient Air Quality for Particulate Matter (40 CFR 50): Emissions in excess of 150 ug/m3 of PM 10 over a 24-hour period shall be cause for shut down of the project, until corrections to the containment are made to comply with this level. Use high volume air samplers in accordance with 40 CFR 50 to monitor for this level. Prior to project startup, perform a minimum of three days baseline monitoring to determine pre-existing conditions.

Ambient Air Quality – Visible Emissions: Visible emissions shall be used as a criterion for project shut down until corrections to the containment are made. Visible emissions shall be determined in accordance with 40 CFR 60. As determined by SSPC Guide 61, visible emission in excess of 20 percent capacity for any 3-minute period in 60 minutes, shall be cause for shut down of the project until corrections to the containment are made to comply with this level.

Ambient Air Quality – Lead Emissions: Monitor and control ambient airborne lead concentration to conform to the EPA Limit of 1.5 μg/m3 average over a 90 day period. Emissions of lead in excess of 15 μg/m3 over an eight hour period shall be cause for shut down of the project until corrections are made to comply with this level. Airborne lead monitoring shall be accomplished using high volume air samplers in accordance with 40 CFR 50. (Refer to Item 1.05 A.2.a.)

1.7.02 Ambient Air Quality for Lead – Personal Air Monitoring to Establish Regulated Areas:

Establish a regulated area surrounding activities where lead exposures exceed the OSHA Personal Exposure Level (PEL) (refer to Item 1.08). This includes the paint removal area, dust collection equipment, abrasive recycling equipment, and locations where lead-containing debris is handled or transferred to storage containers.

Demarcate the regulated area by use of ropes, tape, walls, or other similar means, and post appropriate warning signs. Limit access to these areas to those persons properly trained and protected.

Water Quality: Do not allow the release of lead into bodies of water or storm sewers. Stop work if spills or emissions are observed entering into bodies of water, or are found in areas where storm water run-off could carry the debris into bodies of water or storm sewers.

NPDES Permit: If waste water is discharged to storm sewers or surface water, an NPDES permit shall be obtained in accordance with the requirements of 40 CFR 122. The requirements of the permit shall be strictly followed.

The Contractor is advised that certain discharges of lead compounds into water are a violation of the Clean Water Act. More specifically, 40 CFR 117.3 establishes reportable quantities of hazardous substances released in a 24-hour period, and 40 CFR 117.21 requires immediate notification of the release of a reportable quantity to the appropriate agency (in Michigan, the Michigan Department of Natural Resources). Examples of reportable quantities of lead compounds include: lead arsenate > 1 lb., lead sulfate > 10 lb., lead acetate > 10 lb., lead stearate > 10 lb.

Provide protection at drains to prevent paint debris from entering the storm sewer system.

1.8 CRITERIA FOR CONTROLS OVER WORKER PROTECTION.

Submit written program for worker protection consistent with OSHA lead standard for construction (29 CFR 1926.62)

1.8.01 In addition to the requirements of the OSHA lead standard for construction, the written program shall apply:

Name the individuals responsible for implementing the various requirements of the written program.

Specify that analysis of air monitoring filters shall be performed by an American Industrial Hygiene Association (AIHA) accredited laboratory.

Require that blood level testing shall be conducted by an OSHA-approved laboratory.

Include the name, address, and telephone number of the hospital to which injured workers will be taken, and a map showing the route to be traveled.

Include the telephone number of the ambulance service to be used.

Include the emergency telephone numbers of the local police and fire departments.

Include specifications for the construction of a work area containment. The containment shall be designed to contain debris generated by the removal process applied (such as dust, waste paint, waste abrasive, and water), in accordance with Item 1.06. Information on the design of containment can be found in Appendix F of OSHA Asbestos Standards for the Construction Industry, 29 CFR 1926.58, and Chapter 6 of the "Industrial Lead Paint Removal Handbook".

Identify the location at which Material Safety Data Sheets (MSDS) will be maintained and identify the individual responsible for compliance with the OSHA hazard communication standard (29 CFR 1910.1200).

1.8.02 Include the following minimum emergency response requirements:
The site Health and Safety (H&S) coordinator (or site superintendent if no H&S coordinator is designated) shall assure someone trained in first aid and cardiopulmonary resuscitation (CPR) is present during normal working hours. The site H&S coordinator shall assure that a first aid kit and appropriate fire extinguishers are available at the site and shall inform site workers of their location. The H&S coordinator shall contact the medical facility identified in Item 1.08 to determine if it has facilities to accept workers contaminated with debris present at the site.

In the event of a worker injury, the responding worker shall inform the site H&S coordinator. The site first-aider shall perform first aid. If the worker should be taken to a medical facility, the designated first-aider shall decide whether to decontaminate the worker beforehand, or transport the worker without being clean.

In the event of a fire, the site H&S coordinator shall determine whether conditions warrant assistance from the fire or police department and shall call for assistance. In the absence of the H&S coordinator, the site superintendent shall make the determination.

18.03 Criteria for Handling of Hazardous Waste and Reporting Releases.

The Owner is considered to be the generator of the waste for this project. The contractor is responsible for implementing the following:

1.8.04 Sampling and testing of debris:

Representative samples of the debris shall be tested by TCLP according to method EPS SW-846 to determine if it is hazardous in accordance with Appendix II of 40 CFR 261.

In the case of wet methods of preparation, the use of chemical strippers, or containerized hygiene water, all liquids and sludge shall be tested, including pH to determine corrositivity, if appropriate.

1.8.05 Hazardous waste: If the tests of the sampled debris indicate the waste to be hazardous, the following requirements apply:

Site Storage and Handling: Store and handle the on-site hazardous waste debris in accordance with the requirements of 40 CFR 262 and 40 CFR 265, with special attention given to proper labeling, time of storage, amount of material stored at any one time, use of proper containers, and personnel training. Confirm that an EPA identification number will be obtained, if one has not already been assigned to the facility. Do not place paint debris on the unprotected ground. Adequately shield paint debris to prevent dispersion of the debris by wind or rain water. Provide preparedness, prevention, and contingency plans (PPCP) in accordance with 40 CFR 265 Subpart C and Subpart D for the steps to be taken in the event of an unplanned release or emergency. Evidence of improper storage shall be cause for immediate shutdown of the project until corrective action is taken.

Transportation and Disposal of Debris: Arrange to have the debris transported from the site in accordance with the requirements of 40 and 40 CFR 268. Use only licensed transporters and disposal facilities. Provide signed manifests to verify that all steps of the handling and disposal process have been completed properly.

Clearance Testing: Thoroughly vacuum, wash, or otherwise decontaminate reusable items prior to removal from the project site. Items include, but are not limited to, equipment, containment materials, ground covers, scaffolding, and change and shower facilities. If adequate cleaning is not possible, the materials shall be treated as waste and tested and disposed of properly.

CERCLA Release – The Contractor is advised that the discharge of one or more pounds of lead waste or dust (4 mils or less in diameter) into the atmosphere or water within a 24-hour period is considered a reportable release in accordance with 40 CFR 300 and 40 CFR 302.

1.9 RECORD KEEPING AND ABATEMENT MANAGEMENT.

1.9.01 Document and maintain records of the abatement process. Submit the records upon completion of the abatement of an area, and prior to final payment. The records for each abated area shall clearly describe in non-technical language where the lead was found, and how it was abated. At a minimum, the records shall also include the following:

Complete identification of area(s) receiving abatement.

Results of testing.

General description of abatement methods.

Results of abatement clearance inspections and tests.

Chronology of project-specific abatement from beginning of planning through final clearance testing.

Pertinent Federal, State, and Local requirements under which abatement was undertaken.

Final medical monitoring results.

Drawings clearly showing the location, extent and quantity of lead-based paint removal.

Any outstanding disposal manifests.

Third Party Inspection and Testing

1.9.02 The Contractor shall arrange and pay all associated costs for the services of an independent, third-party consultant who will perform the following activities:

Perform environmental monitoring to review compliance with the intent of the specification.

Perform a preliminary visual inspection as specified in Item 3.04 D.3.

Perform final inspections and clearance testing as specified in Items 3.05 and 3.06.

The third-party consultant shall have all appropriate certifications for providing the required testing and inspection services.

PART 2 - PRODUCTS

2.1 EQUIPMENT.

HEPA vacuums: HEPA (High Efficiency Particle Air) vacuums differ from conventional vacuums in that they contain high-efficiency filters that trap extremely small, micron-sized particles. These filters can filter out particles of 0.3 microns or greater (from a body of air) at 99.97 percent efficiency or greater. Lead dust tends to break down into extremely fine, micron-sized particles. Vacuuming by conventional means is unacceptable at any time, especially in lead-paint abatement final cleanup, because much of the fine lead dust will simply be exhausted back into the environment. Consequently, the use of a HEPA vacuum is required.

Related attachments: As necessary for the conditions encountered, and including items such as brushes of various sizes, crevice tools, and angular tools.

Other equipment, including personal safety equipment, as necessary to comply with the requirements of this specification.

2.2 MATERIALS.

High-phosphate detergent: Detergents with a high-phosphate content [containing at least 5 percent tri-sodium phosphate (TSP)].

Related cleaning supplies: As necessary to accommodate the conditions encountered, and including such items as wringer buckets, mops, squeegee sponge mops, variously sized hand sponges, and rags.

Polyethylene sheeting: 4-mil and 6-mil thickness.

Polyethylene spray: Product approved for intended use by the manufacturer.

Miscellaneous materials such as storage drums, framing lumber, masking adhesive tapes, spray glues, stapling devices, as necessary to meet the requirements of this specification.

PART 3 - EXECUTION

3.1 SITE PREPARATION: PRIOR TO WORK START.

3.1.01 Post warning signs at all entrances and exits to work areas. The warning signs shall read as follows:

“CAUTION LEAD HAZARD

DO NOT ENTER WORK AREA UNLESS AUTHORIZED”

Ensure that heat, electricity, and water are available in the areas to be abated. Ensure that there are no existing water leaks of any type (including from such sources as roofs, windows, or plumbing related components).

Correct other conditions that can impede abatement or cause the abatement to fail.

Initiate containment procedures to protect surfaces and contain and control lead dust debris as specified in Item 3.02.

3.2 CONTAINMENT.

If the abatement plan necessitates the breaking or disturbing of leaded surfaces or other dust generating procedures, and therefore the generation of lead dust, provide containment procedures in accordance with the criteria in Items 1.06 and 1.07 and as indicated below. If abatement does not break or disturb lead-painted surfaces, provide containment measures only as necessary to protect surfaces from damage.

3.2.01 The following materials may be used for containment:

Polyethylene (plastic) sheets at least 6 mils thick;

Heavy duty tape (e.g., duct tape) to fasten plastic sheets;

Staple gun with heavy duty staples for fastening plastic sheets.

3.2.02 Alternate products include:

Polyethylene spray instead of plastic sheeting (the dry film can be removed later by peeling);

Spray glue in aerosol can for fastening plastic sheets.

3.3 CONTROLLING OFF-SITE DISPERSAL.

3.3.01 Limiting access: Prior to satisfactory clearance testing, limit access to the abatement work areas to the following:

Contractor and designated employees;

State, County or Local enforcement officials, or their designees;

Inspectors with a security interest in the building; and,

Federal, State or Local officials, or their designee, engaged in research on lead.

3.3.02 Limiting Tracking of Dust and Debris:

Persons entering a work area during a lead abatement project involving breaking or disturbing lead-painted surfaces shall wear disposable shoe covers. The shoe covers shall be removed upon leaving the work area and placed with abatement waste.

Persons entering a work area during lead paint removal activity (e.g., by heat gun, scraping, HEPA sander, or chemical) or during replacement and during the cleanup process shall also wear appropriate respirator protection. Worker protection shall be in accordance with Item 1.08.

Program of On-Going Cleanup: Implement a program of on-going cleanup in the lead abatement work area. The frequency and intensity of cleaning will be the greatest with on-site paint removal methods, and methods that create a lot of construction debris. On-going cleanup shall include the regular cleaning of all tools, equipment, and worker protection gear to minimize worker exposure, and the risk of transferring lead to other job sites.

3.4 CLEANUP.

3.4.01 General:

Perform cleanup activities as previously specified and as indicated in this item.

Coordinate abatement activities to ensure proper conformance to the project cleanup requirements.

3.4.02 Cleanup Methods and Procedures: The following two basic cleaning methods shall be used to clean the surfaces of the galleries at the conclusion of the active lead based paint abatement activities:

3.4.03 Dry cleaning method, using HEPA vacuums:

Operation instructions: Operate the HEPA vacuum in accordance with the requirements and recommendations of the vacuum manufacturer. If possible, arrange training sessions with the manufacturer’s representative.

Special attachments needed: Ensure that a variety of vacuum attachments (such as brushes of various sizes, crevice tools, and angular tools) are available to accommodate the conditions encountered. Ensure that the attachments are properly used.

3.4.04 HEPA vacuuming procedures: Include all rooms of the property in this HEPA process, except for rooms that were found free of lead paint and lead dust before the abatement process began, and were never entered during the process:

Thoroughly and completely vacuum all abated surfaces in the abatement area. These surfaces include, but are not limited to: ceilings, walls, floors, pipes and fixtures of any kind (light, electrical).

Thoroughly and completely vacuum all unabated surfaces exposed to lead dust generated by the abatement process.

Start vacuuming at the ceilings and work down to the floors. Pay particular care to rough or porous surfaces, such as weathered or worn surfaces and masonry surfaces, particularly concrete, where lead dust tends to tenaciously adhere.

Maintenance of the HEPA vacuum: Properly maintain HEPA vacuums in accordance with the vacuum manufacturer's instructions.

Use extreme caution when opening the HEPA vacuum for filter replacement or debris removal, due to the high potential for accidental release of accumulated lead dust into the environment. This can occur if the vacuum's seal has been broken and the vacuum's bag is disturbed.

Operators shall wear a full set of protective clothing and equipment, including appropriate respirators, when performing these maintenance functions.

3.4.05 Wet cleaning method, using a high phosphate detergent wash:

Manufacturer's instructions: Carefully follow the specific manufacturer's instructions for the proper use of the product, especially the dilution ratio recommended. Wear waterproof gloves when handling the detergent wash to prevent skin irritation.

Cleaning equipment: Ensure that a variety of cleaning equipment is available (such as wringer buckets, mops, squeegee sponge mops, variously sized hand sponges, and rags) to accommodate the conditions encountered. Ensure that the cleaning equipment is properly used.

3.4.06 Wet cleaning procedures:

After the HEPA vacuuming, thoroughly and completely wash all surfaces in the abatement area with the high phosphate solution. These surfaces include, but are not limited to: ceilings, walls, floors, doors and fixtures of any kind (light, electrical).

Thoroughly and completely wash all unabated surfaces exposed to lead dust generated by the abatement process.

Begin the washing activities at the ceilings and work down to the floor.

Change cleaning mixture regularly: To avoid re-contaminating the area by using overly dirty water, users should carefully follow the surface area limits provided by the manufacturer and change the cleaning mixture accordingly. In cases where the manufacturer does not indicate surface area limits, the cleaning mixture should be changed at least after each room has been washed. Each time the cleaning mixture is changed, users must ensure that the dirty water does not recontaminate the environment.

3.4.07 Special Procedures During Abatement:

Daily cleanup: Perform the following cleanup activities daily. Handle, store, and dispose of debris in accordance with Items 1.09 and 1.10.

Small debris: Spray the affected surfaces with a fine mist of water, to keep surface dust from becoming airborne. Place the swept debris in double 4-mil or single 6-mil plastic bags, properly seal the bags, and move them to the designated trash storage area. Do not overload trash bags to ensure that no ruptures or punctures occur during handling and transport.

During daily cleanup activities, workers shall wear protective clothing and equipment. Also, during daily cleanup activities, abatement workers shall inspect for areas of the plastic requiring repair. Holes and rips found shall be patched with 6-mil plastic and duct tape immediately after cleaning.

3.4.08 Special Procedures After Abatement:

Preliminary final cleanup: Prior to final cleanup and painting or sealing of the abated surfaces, remove and properly dispose of the plastic sheeting used for containment.

Begin removals with the upper-level plastic. Spray or mist the plastic with water to hold down dust and then fold the plastic in upon itself to trap any dust residue inside.

Before removal of floor plastic, spray the plastic and sweep as indicated in Item 3.04C. Fold the plastic carefully from the corners/ends to the middle to trap any remaining lead dust. Place the plastic into double 4-mil or single 6-mil plastic bags, properly seal the bags, and remove the bags from the premises.

As with daily cleanups, this plastic removal process requires the use of protective equipment, especially appropriate respirators.

Do not remove plastic sheets used to isolate contaminated rooms from non-contaminated rooms at this time. These sheets shall remain in place until after the preliminary final cleanup is complete and then carefully removed as described above.

3.4.09 After the plastic has been removed from the contaminated area, perform the following cleanup activities:

HEPA vacuum the entire area as specified in Item 3.04 B.1. Start with the galleries farthest from the entrance to avoid re-tracking dust through the already-cleaned area. In each gallery, begin vacuuming at the ceilings and proceed down the walls, making sure every surface is treated, including, but are not limited to: ceilings, walls, floors, pipes and fixtures of any kind (light, electrical).

Wash down the entire affected area with a high phosphate detergent as specified in Item 3.04 B.2.

HEPA-vacuum the affected area again, as specified in Item 3.04 B.1.

Cleaning of workers, tools, equipment and vehicles:

Personal hygiene: Workers shall carefully follow the personal hygiene procedures of 29 CFR 1926.62.

Supplies: Regularly replace consumable/disposable supplies, such as mop heads, sponges, and rags, at least at the end of each abatement project or monthly, whichever comes first. Treat soiled items as contaminated debris.

Equipment: Clean durable equipment, such as power and hand tools, generators, and vehicles, at least at the end of each abatement project or monthly, whichever comes first. This cleaning shall consist of a thorough HEPA vacuuming and washing with a high phosphate solution.

Preliminary visual inspection:

After the preliminary final cleanup effort is completed, the independent, third-party consultant shall visually inspect the entire affected area to ensure that all surfaces requiring abatement have been addressed, and all visible dust and debris have been removed. If the results of the visual inspection are unsatisfactory, affected surfaces shall be re-abated and/or re-cleaned, in accordance with the inspector’s instructions, at the Contractor’s expense, until satisfactory results are achieved.

3.4.10 Final cleanup: After painting/sealing is complete, perform the following final cleanup activities in the entire affected area:

HEPA-vacuum the area as specified in Item 3.04 B.1.

Wash down the area with a high phosphate detergent as specified in Item 3.04 B.2.

HEPA-vacuum again as specified in Item 3.04 B.1.

3.4.11 Final inspection:

3.4.12 After the final cleanup is complete, the independent, third-party consultant shall perform a final inspection to:

Verify that the abatement work is in compliance with the specifications.

Detect the presence of lead dust.

The Owner’s Environmental Consultant will perform both a visual inspection and clearance testing of lead levels in surface dust as specified in Items 3.05 and 3.06.

3.5 POST-ABATEMENT VISUAL INSPECTION.

The independent, third-party consultant shall confirm job completeness by determining whether all surfaces have been abated according to the approved abatement plan. Special attention will be given to areas where lead paint has been removed adjacent to paint that is intact (for example, where paint has been removed from a door frame but non-lead paint is left on the baseboard). Ensure that paint at this joint is sound. The independent consultant shall verify that all abated surfaces and floors have been repainted or otherwise sealed.

The independent, third-party consultant shall determine whether the area has been adequately cleaned by observing all surfaces for dust and debris.

3.6 TESTING ASSOCIATED WITH THE CLEARANCE PROCESS.

Upon completion of final cleanup and post-abatement visual inspection, the independent, third-party consultant shall test remaining surface dust to verify that only acceptable levels of lead dust remain before returning the area to active operation. This surface dust testing process is referred to as clearance criteria.

Surface dust sampling and testing shall be performed no sooner than 24 hours after completion of post-abatement cleanup activities, to allow any airborne lead dust present to settle

The surface wipe sampling method will be used for surface dust sampling. This method uses commercial wipes moistened with a non-alcohol wetting agent. Surface dust sampling will not be performed if there is a visible accumulation of dust or debris. In this case, surface wipe sampling will be deferred until the contractor completes a thorough cleanup.

Upon determination that lead dust is within acceptable levels the independent third-party consultant shall issue an “Authorization for Re-Occupancy” and “Certification of Visual Inspection”.

3.7 WASTE DISPOSAL – GENERAL.

Prior to the start of abatement operations, determine which waste materials may be hazardous. Keep hazardous waste segregated from solid waste, so that proper disposal of the waste material can be achieved.

Do not leave waste on the property in an unsecured area. Do not dump waste by the roadside, or in a nearby unauthorized dumpster. Do not burn or incinerate waste, due to the danger from lead fumes.

Do not flush lead-contaminated wash water into storm drains or sanitary sewers without permission of local authorities.

3.8 SOLID WASTE (NON-HAZARDOUS) DISPOSAL:

Dispose of solid waste which has been evaluated and determined not to be hazardous in a State approved landfill. Wrap large debris in 6-mil plastic, seal with tape, and move to the trash storage area.

Transport the waste to the disposal facility in covered vehicles. Do not use residential or commercial trash collection services without approval of State and local authorities. Covered dumpster services are acceptable, if the service company is informed of the presence of lead, and that appropriate disposal methods are used.

3.9 HAZARDOUS WASTE DISPOSAL.

Dispose of hazardous waste at a hazardous waste disposal facility, usually called a treatment storage and disposal facility (TSD). A TSD shall have an EPA ID number and authorization (either a permit or “interim status”) to operate. It is the responsibility of the abatement contractor to ensure that the TSD meets all legal requirements. The TSD can advise on appropriate packaging of waste, restrictions on disposal (e.g., liquids in landfills), and technical issues, such as methods for removing liquids from wastes.

Transporters shall have an EPA ID Number and must meet U.S. Department of Transportation (DOT) requirements for shipping containers. A good transporter will be able to advise the abatement Contractor on bagging and special handling of hazardous wastes.

Take special care when removing hazardous waste from the abatement site, in order to avoid environmental contamination or injury to workers or residents. While in the work area, the exterior of the filled waste containers shall be HEPA vacuumed and wet-wiped to remove residual contamination. If plastic bags are used, they shall be bagged again as they come out of the work area. Remove waste from work areas at times when employee use of hallways and stairwells is low. The path from the work area to the truck or dumpster shall be planned in advance to minimize contacts with employees.

Containers shall be moved and packed into the truck with care. When possible, use hand trucks, dollies, or pull cars, along with ramps or trucks with lift gates. These procedures will help minimize container breakage and consequent exposure of residents or employees to hazardous waste.

Submit signed manifests to verify that all steps of the handling and disposal process have been completed properly.

End of section

SECTION 02100

SITE CLEARING

PART 1 – GENERAL

1.1 SCOPE. Section includes removal of surface debris; removal of paving, curbs; removal of trees, shrubs, and other plant life; removal of underground storage tanks if encountered; removal of abandoned utilities; and topsoil excavation and removal of existing fencing.

1.2 GENERAL.

1.2.01 Definitions.

Site clearing includes clearing site, loading and removing waste materials from site, and applying herbicide to designated plant life. The removal of trees with diameter of less than 8 inches (20.3 cm) as measured at a point 4 ½ feet (1.4 m) above the base of the tree at the ground line will be included in the payment for site clearing.

Tree and stump removal includes removal, disposal, backfilling with approved materials and applying herbicides as needed.

Trees having major limbs lower than 4 ½ feet (1.4 m) from the ground will be measured at the smallest diameter below such limbs.

Fence removal includes removing and disposing of the fence materials and gates and backfilling the post holes as required.

Pavement removal includes full depth removal of bituminous, concrete, bituminous over concrete at or any other pavement materials, sawcutting and disposal of removed material. Pavement removal shall be measured by the square yard.

Curb and curb gutter removal includes sawcutting, removal and disposal of removed material.

Sidewalk removal includes sawcutting, removal and disposal of removed material.

PART 2 – PRODUCTS

2.1 MATERIALS.

2.1.01 Herbicide. Use Banvel CST or an equal approved by the Engineer.

2.1.02 Fill Material. Granular Material Class III as per current edition of MDOT Standard Specifications for Construction.

PART 3 – EXECUTION

3.1 PREPARATION. Verify that existing plant life designated to remain is tagged or identified. Identify a waste area for placing removed materials.

3.1.01 Protection. For protection of underground utilities and according to Public Act 53, 1974, the Contractor shall dial Miss Dig 1-800-482-7171 a minimum of three full working days, excluding Saturdays, Sundays, and holidays, before beginning each excavation in areas where public utilities have not been previously located. Utility members will also be routinely notified. This does not relieve the Contractor of the responsibility of notifying utility owners who may not be a part of the Miss Dig alert system.

Protect trees, plant growth and features designated to remain as final landscaping. Protect benchmarks, survey control points and existing structures from damage or displacement.

3.1.02 Clearing. Clear areas required for access to site and execution of work. Remove trees and shrubs within construction areas as directed by the Engineer. Remove stumps, and roots. Where stumps may not be removed to avoid damages to existing utilities, apply herbicide to remaining stumps to inhibit growth.
Clear undergrowth and deadwood without disturbing subsoil.

3.1.03 Removal. Remove debris, and extracted plant life from site. Remove payment, driveways, curb, gutters, sidewalk, to and existing joint or sawed joint. Bituminous and concrete shall be sawed to full depth. Adjacent cut soils or base materials removed when removing concrete shall be replaced with a similar material acceptable at the Contractor’s expense.

Removed materials shall become the property of the Contractor unless otherwise shown on the plans or in the proposal. Materials reserved for use by the Owner shall be removed without damage and delivered to a location directed by the Engineer. Materials not incorporated into the new work, which become the property of the

Contractor, shall be properly disposed of before acceptance of the project. Salvaged materials meeting specification requirements may be used in the new work, if approved.

For all material placed outside of the right-of-way, the Contractor shall furnish the Engineer written permission from the property owner of the disposal site. Disposal will not be permitted in a wetland or flood plain unless permits are obtained from the appropriate regulatory agencies.

3.1.04 Topsoil Excavation. Excavate topsoil from entire site without mixing with foreign materials for use in finish grading. Do not excavate wet topsoil. Stockpile in area designated on site to depth not exceeding 6 feet (1.8 m) and protect from erosion. Material shall be stockpiled on impervious material and covered over with the same material until disposal. Remove excess topsoil not intended for reuse from site as directed by the Engineer.

End of Section

SECTION 02140

DEWATERING

PART 1 - GENERAL

1.1 SCOPE. This section includes all dewatering or groundwater control work complete with design, construction and operation and abandonment of dewatering or groundwater control systems, protection of personnel and structures, and environmental protection and restoration.

1.2 GENERAL.

1.2.01 Coordination. Perform dewatering work as necessary to lower and control groundwater levels and hydrostatic pressures to permit excavation and construction to be performed in near-dry conditions. Control of surface and subsurface water, ice and snow are part of dewatering requirements.

Where applicable, the Contractor shall obtain and pay for all permits and inspections for dewatering construction in accordance with the provisions of Part 91 PA 451, State of Michigan, and all local government agencies having jurisdiction. No additional claim for compensation shall be allowed because of the Contractor's failure to obtain or pay for such permits and inspections.

1.2.02 Governing Standards. All dewatering systems design and construction shall conform to the provisions of the "Soil Erosion and Sedimentation Control Act of the State of Michigan, Part 91 of Act 451; PA of Michigan."

Dewatering operations shall conform to the requirements of all federal, state, and local agencies having jurisdiction.

1.3 QUALITY ASSURANCE. Contractor shall be responsible for the complete design of all structures and methods proposed for dewatering the project site, including the implementation of all materials, tools and equipment proposed for use in the Work. Temporary wiring with the dewatering shall comply with applicable portions of the National Electrical Code.

1.4 SUBMITTALS. Submit proposed dewatering plan and methods, including all proposed equipment to be used. Identify any scheduling or sequencing requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Control of groundwater shall be accomplished in a manner that will preserve the strength of the foundation soils, will not cause instability of the excavated slopes, and will not result in damage to existing structures. Where necessary to this purpose, the water will be lowered in advance of excavation by wells, well points, or similar methods. Open pumping will not be permitted if it results in boils, loss of fines, softening of the subgrade, or slope in stability. Wells and well points will be installed with suitable screens and filters so that pumping of fines does not occur. Discharge will be arranged to facilitate sampling by the Engineer.

Take all steps necessary, during the Work of this Section, to protect surrounding property and adjacent buildings, private water supplies, roads, drains, sewers, structures, and appurtenances. Adequate measures shall be taken to protect such property and construction from the effects of the dewatering operations.

PART 3 - EXECUTION

3.1 INSPECTION. Prior to beginning any work, Contractor shall verify in the field the location, type and capacity of all existing drainage facilities and conditions which will affect the Work of this Section. No allowances shall be made for conditions found during the progress of the dewatering operations because of the Contractor's failure to verify such conditions.

The Contractor shall make field verification of all existing structures and utilities at the site of the Work which are scheduled to remain and which may be affected by the Work of this Section. The Contractor shall be responsible for any damage to existing structures and/or utilities caused because of his Work and shall repair such damage at his expense to the satisfaction of the Engineer.

3.2 PREPARATION. The Contractor shall review the soil report prior to bidding this project and shall consider this in the design of their dewatering or groundwater control systems.

3.3 INSTALLATION. Provide an adequate system to lower and control groundwater in order to permit excavation, construction of structures, and placement of fill materials under dry conditions. Install sufficient dewatering equipment to pre-drain water-bearing strata above and below bottom of structure foundations, drains, sewers, and other excavations. The excavations shall be kept dry until exterior walls have been completed and until the structures have been backfilled. Drainage ditches shall not be placed within the area to be occupied by any structure except where permitted by Engineer. When such ditches are placed beneath the structures, they shall be backfilled with Class C (3000 psi) concrete.

Reduce hydrostatic head in water-bearing strata below structure foundations, drains, sewers and other excavations to extent that water level and piezometric water levels in construction areas are below prevailing excavation surface.

Prior to excavation below groundwater level, place system into operation to lower water levels as required and operate it continuously 24 hours a day, 7 days a week until drains, sewers and structures have been constructed, including placement of fill materials, and until dewatering is no longer required.

Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others engaged in work about the site. Provide sumps, sedimentation tanks, and other flow control devices as required by governing authorities.

Provide standby equipment on site, installed and available for immediate operation if required to maintain dewatering on a continuous basis in an event any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform work as may be required to restore damaged structures and foundation soil at no additional expense to the owner.

3.4 PERFORMANCE. The Contractor shall maintain all finished excavation work free of water during the preparation of the subgrade and until the completion of the work. No ground or surface water shall be discharged into any existing sanitary sewer. No unit of work shall be constructed under water except as otherwise directed by the Engineer. Provide and maintain adequate dewatering equipment to remove and dispose of all surface or groundwater entering excavations, trenches or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the construction is complete. All excavations which extend down to or below the static groundwater elevation shall be dewatered by lowering and maintaining the groundwater level beneath such excavations at distance of not less than 12 inches below the bottom of the excavation or as directed by the Engineer. Drainage system methods shall not cause any damage to wells or adjacent property. All outlet drainage piping and conduit shall be kept clean and free from sediment. The Contractor shall be held responsible for the condition of all pipes, conduits and structures, which he may use for drainage.

Sumps and pump wells used as a part of the dewatering system shall be strongly sheathed and braced to protect the construction while in use. Tops of well casings must be covered to prevent animals and debris from entering and shall be 2 to 3 feet (61 to 91.5 cm) above ground. Sumps and wells, when abandoned, shall be backfilled and compacted to the satisfaction of the Engineer.

Methods used in drilling wells associated with dewatering or groundwater control systems shall be the responsibility of the Contractor and shall be acceptable to the Engineer. Drilling methods shall insure proper placement of well materials and shall not involve displacement of earth formations. Drilling shall be done with equipment of proper type and in good condition, acceptable to the Engineer.

Equipment for pumping and pumping methods associated with dewatering or groundwater control systems shall be the responsibility of the Contractor and shall be acceptable to the Engineer. The Contractor shall construct or furnish adequate discharge piping to conduct and dispose of the water so as to prevent damage to existing structures or property. Pumping equipment shall be of proper type and size for the work and in good condition and shall be acceptable to the Engineer. Provide all anchors and supports for pumping equipment.

Upon completion of dewatering work for the Project, abandon and/or fill all holes, trenches, ditches and other earth excavations created by the work of this Section and not scheduled to remain. Do all filling, backfilling and grading to restore excavations and earth banks to the lines and levels indicated on the Plans and as directed by the Engineer. All earth fills shall be compacted to a density equal to that of the surrounding undisturbed earth.

End of Section

SECTION 02145

SLUDGE REMOVAL

PART 1 - GENERAL

1.1 SCOPE. The Contractor shall furnish all labor, supervision, materials, tools, equipment and incidentals specified and required to clean walls, floors, ceilings, and columns of wet wells. Contractor shall clean, transport and dispose material at a city approved disposal facility. Contractor will not be permitted to discharge grit into any part of the pumping station.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 WET WELL CLEANING. Cleaning of wet well shall include the removal of slime, sludge, and any organic material from the walls, floors, ceilings and columns of wet wells after each well has been dewatered. Additionally, Contractor shall thoroughly clean pump suction bells under this contract to remove all debris and deposits to render the site clean.

Cleaning of the dewatered wet well shall be conducted by workmen experienced in such work and all necessary equipment shall be provided. Cleaning methods shall be approved by Engineer. Contractor should anticipate the dewatered wet wells will contain grit as well as sludge.

Contractor shall furnish and install all temporary pumps, fittings, and hosing necessary to supply adequate water pressure to completely clean all internal surfaces of the dewatered wet wells and the pump suction bells. All necessary electrical connections and wiring to bring power to any cleaning equipment shall be provided by the Contractor

Contractor shall not discharge any wash water that contains grit to any sewer. Contractor may be permitted to discharge wash water to the sewer if he can prove to the satisfaction of the Engineer that such discharge is grit free. Contractor shall furnish all necessary grit removal facilities to accomplish such grit free discharge, as required.

Contractor shall provide adequate lighting, ventilation and safety equipment as required and shall comply with all applicable confined space entry regulations whenever workmen are to enter the wet well in connection with this work.

3.2 REMOVAL OF WET WELL CONTENTS. Contractor shall furnish all necessary equipment, pumps, piping, hosing, and any additional items required to completely remove all grit, sludge, and other material from the dewatered wet well. All sludge/grit removal operations shall be conducted which strict observance of governing regulation, and with approval of Engineer. Upon completion of the work, Engineer will conduct suitable test to determine whether the work has been performed properly and that all contents have been removed from the wet wells.

3.3 SLUDGE TRANSPORTATION. The Contractor shall furnish suitable means for the transportation of sludge and grit to an MDEQ approved location for disposal. Sludge transportation shall be undertaken by the Contractor in strict accordance with all the local ordinances and state and federal regulations and guidelines, in an environmentally safe, nuisance free manner. Contractor shall haul sludge in approved trucks registered for waste hauling. For the protection of the Owner, copies of such licenses and registration numbers shall be furnished to the Engineer prior to the undertaking of any work at the site.

3.4 SLUDGE/GRIT DISPOSAL. Contractor's method of disposal shall fully comply with all local ordinances, state and federal regulations and shall meet the Engineer approval before execution by the Contractor. Before commencing any work, the Contractor shall inform the Engineer in writing as to the method of sludge/grit disposal and shall provide written documentation to the Engineer that Contractor has secured access to a specific legal disposal site and that disposal at the site is not in violation of any federal, state, or local requirements. Contractor shall be responsible for testing material in compliance with the laws and regulations governing the work. Contractor shall be responsible for all costs related to the testing of material.

3.5 CLEANUP AND RESTORATION. Any sludge or grit which is spilled by the Contractor shall be cleaned up immediately. Contractor shall ensure that no area, including that in the immediate vicinity of the work, is permitted to become fouled, odorous or unsightly, due to cleaning of the wet wells. Contractor shall cease work upon receiving notice from Engineer until the problem is corrected.

3.6 INSPECTION. Contractor shall submit written request to Engineer for inspection of cleaned facility in accordance with Master Specifications Section 01190, Contract Closeout and Cleaning. Contractor shall remedy deficiencies as requested by Engineer.

End of Section

SECTION 02211

EXCAVATING, FILLING AND GRADING

PART 1 - GENERAL

1.1 SCOPE. This section covers general earthwork activity and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excess excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; construction of fills and embankments; surfacing and grading; and other appurtenant work.

1.2 GENERAL. With reference to the terms and conditions of the construction standards for excavations set forth in the OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, the Contractor shall employ a competent person and, when necessary, a registered professional engineer, to act upon all pertinent matters of the work of this section.

Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

With reference to geotechnical instrumentation; the Contractor must coordinate installation of all instrumentation for construction activities with the Engineer and all instruments are to be installed in sufficient time prior to a construction activity to take baseline readings.

Conform to applicable state and local codes for disposal of excavated materials judged not suitable for backfill. Obtain disposal permit from local enforcing agency. Obtain permission to use any storm sewers, drains, or ditches for dewatering purposes. Ensure Soil Erosion and Sedimentation Control Program is followed.

1.3 QUALITY ASSURANCE. The Contractor shall utilize the services of a registered professional engineer, experienced in the design and analysis of all aspects of below grade construction, for the determination and control of the Contractor’s means and methods of performing the work. Such means and methods shall be approved by the Engineer in advance of their use.

However, the approval by the Engineer shall not release the Contractor from liability for injury to persons, damage to property, or poor workmanship.

Use AASHTO T-180 Modified Method C, AASHTO T-99 “One Point Test”, or the Cone Density Method developed by MDOT to determine maximum unit weight.

Do work in accordance with the U.S. Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54).

For geotechnical instrumentation the quality assurance refers that:

> The Contractor shall retain a qualified survey firm with a minimum of five years experience. The surveyor supplied by the survey firm shall be a licensed surveyor in the State of Michigan with a minimum of four years of experience in similar work. The surveyor’s experience shall have included determination of horizontal displacement to the accuracy specified hereinafter.
>
> The geotechnical engineering firm retained by the Contractor as a specialty subcontractor, assigned to install and monitor instrumentation must have at least five years of experience in installation and monitoring of the types of instruments specified herein.
>
> The geotechnical instrumentation specialty subcontractor shall provide a qualified Geotechnical Instrumentation Engineer who is a registered Professional Engineer in the State of Michigan who has a minimum of a Masters degree in geotechnical engineering, and who has at least five years of experience in installation and monitoring of the types of instruments specified herein.

1.4 SUBMITTALS.

1.4.01 Drawings and Data Submit detailed sequenced pre-excavation, excavation and backfilling plans for all work. Prepare and submit a Certificate of Design for each temporary sheeting system not detailed on the Drawings. Submit design calculations and necessary Drawings for shaft bracing, ground water control, ventilation requirements and geotechnical concerns.

Submit product data on geotextile separator and filter fabric.

1.4.02 Certifications. For dewatering systems, submit a Certificate of Design, support data, and detailed plans indicating proposed type and location of dewatering system, type and location of geotechnical instrumentation and point of disposal of pumped water.

Submit Certificate of Design for each temporary earth retention system not detailed on the drawings. Design of all temporary earth retention systems shall be by a Registered Professional Engineer in Michigan.

1.4.03 Samples. Provide 0.5 cubic foot (0.014 cubic meter) samples of all proposed materials in sealed plastic buckets taken furnished material.

1.4.04 Test Reports. Submit field density test reports. Submit gradation test for all furnished material.

1.4.05 Record Drawings. Record location of underground utilities and other construction on project record drawings.

1.4.06 Geotechnical Submittals. Provide a geotechnical instrumentation monitoring plan for protection of existing surface and underground facilities and utilities. Indicate all planned measures to monitor and control soil movements, water, vibrations or any other conditions that could potentially endanger existing facilities. Indicate planned location of instruments, parameter to be monitored by each instrument at each location, reading frequency, action levels for each instrument, outline of remedial action, and procedures for ensuring reading correctness. Manufacturer's product data shall be identified on all instruments.

Procedures for all instruments specified herein, for factory calibration, acceptance tests, installation, field calibration, collection of initial data, collection of subsequent data, date reduction, processing of plotting and reporting, protection from damage, and maintenance, together with all required field and office forms.

Within two days of receipt of each instrument at the site, submit to Engineer a copy of factory calibration.

Prior to installing each instrument, submit to Engineer the planned location for that instrument.

Within five days of installing each instrument, submit to Engineer asbuilt location as specified, and installation record sheet.

Within 24 hours of reading an instrument, submit to Engineer plotted data. When readings indicate soil or structure movement the Engineer shall be notified immediately.

For Geotechnical instrumentation, the manufacturer of each instrument shall provide an instruction manual that shall include:

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Provide and maintain barricades, warning lights, warning signs, and other protection required by applicable laws for safety of persons and property.

Protect benchmarks, adjacent structure, utilities, and property during construction operations. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent earth movement. Costs associated with replacing damaged elements and items shall be borne by the Contractor.

Notify Engineer of unexpected subsurface conditions, provide adequate safety measure and discontinue affected work in area until notified to resume work.

2.2 MATERIAL.

2.2.01 Filter Fabric. Filter fabric shall be a nonwoven fabric consisting of only continuous chains of polymeric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the following properties:

Property	Test Method	Unit	Minimum Average Roll Value (weakest principal direction)
Fabric Weight	ASTM D3776	oz/yd^2	5.7
Grab Strength	ASTM D4632	lb	155
Grab Elongation	ASTM D4632	percent	60
Apparent Opening Size	CW-02215	U.S. Standard Sieve Size	70

The filter fabric shall be provided in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris.

2.2.02 Geotextile Separator. Geotextile with Grab Tensile Elongation at – Break less than 50 percent shall meet the requirements in the column for woven geotextiles. Geotextiles with Grab Tensile Elongation-at-Break equal to or greater than 50 percent shall meet the requirements of column for non-woven geotextiles below.

Property/Test Method	Woven	Non-Woven
ASTM D4632 Grab Tensile Strength, lb.	270 min	200 min
ASTM D4553 Trapezoid Tear Strength, lb.	100 min	75 min

ASTM D4833 Puncture Strength, lb.	100 min	75 min
ASTM D4751 Apparent Opening size, inch	8 x 10^{-3}	8 x 10^{-3}
ASTM D4491 Permittivity, Sec-1	0.05 min	0.5 min

2.2.03 Polyethylene Film. Polyethylene film shall be Product Standard PS17.

2.2.04 Granular Fills. Granular fill material shall be crushed rock or gravel; shall be free from dust, clay, and trash; and shall be graded 1-1/2 inch (3.8 cm) to No. 4 as defined in ASTM C33. Refer to the Drawings for locations of specific fill materials to be placed.

2.2.05 Bank-run Gravel. Division 9, current MDOT Standard Specifications for Construction. Granular Material for Fill, Class I or such other sizes as may be approved. Fill may be approved excavated material or can be obtained from approved natural deposits and unprocessed except for the removal of unacceptable material and stones larger than the maximum size permitted. Material shall be free from vegetation and substantially free from loam and other organic matter, clay, other fine or harmful substances, frost snow, ice, and aggregations of frozen soil particles. Compact thoroughly by means of suitable power-driven tampers or other power-driven equipment to density indicated on the Drawings.

2.2.06 Class II Granular Material. Division 9, current MDOT Standard Specifications for Construction. Approved sand, gravel, crushed stone, blast-furnace slag or combination thereof, with 100% passing 3 inch (7.6 cm) sieve, 60 to 100% passing 1 inch (2.5 cm) sieve, 0 to 30% passing No. 100 sieve, and loss by washing not to exceed 7%, per MDOT Standard Specifications 8.02.06 for Granular Material Class II.

2.2.07 Select Borrow. Division 9, current MDOT Standard Specifications for Construction. Granular Material for Fill, Class III or such other sizes as may be approved. Maximum stone size 6 inch (15.2 cm) and material well-graded throughout entire size range. Borrow free from roots, leaves, and other organic materials. Borrow also free of ice or frost and no aggregations of frozen soil particles. Moisture content of borrow within plus or minus 3 percent optimum moisture content at the borrow source. Compact thoroughly by means of suitable power-driven tampers or other power-driven equipment to the density indicated on the Drawings.

2.2.08 Sand. Division 9, current MDOT Standard Specifications for Construction , type 2NS sand or such other sizes as may be approved by the Engineer.

2.2.09 Aggregate Base Material. Division 9, current MDOT Standard Specifications for Construction. Aggregate base for aggregate surfaced or paved surfaces, Michigan Department of Transportation series 21AA or such other sizes as may be approved by the Engineer.

2.2.10 Graded Gravel. Gravel for compacted trench backfill shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
1 inch (2.5 cm)	100
¾ inch (1.9 cm)	85 – 100
3/8 inch (1.0 cm)	50 – 80
No. 4	35 – 60
No. 40	15 – 30
No. 200	5 – 10

The gravel mixture shall contain no clay lumps or organic matter. The fraction passing the No. 4 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. An alternative material may be used if approved by the Engineer.

2.2.11 Select Excavated Material. Select excavated material shall be of a type, which can be compacted to the density specified. Such material shall be free from rubbish or debris, frozen lumps, boulders, or concrete fragments, sod, organic material, tree roots, stumps, branches or other timber. Select excavated material considered suitable for backfill shall be sand, sand-gravel mixture, clean clay, or a combination thereof.

Generally, blue clay, foundry sand, organic material and slag shall not be considered a suitable backfill material.

2.2.12 Earthfills, Embankments, Engineered Fill And Structure Backfill. Only the soils comprising the ASTM D2487 classifications GW, GP, GM, GC, SW, SP, SM, SC, CL and ML and having a plasticity index of less than 25 shall be used for earthfills, embankments, engineered fills and structure backfill. The material shall be free from rocks or stones larger than the specified size, brush, stumps, logs, roots, debris and other organic or deleterious materials.

2.2.13 Lean Concrete. Lean concrete shall be a mixture of Portland cement, aggregate and water, having a minimum compressive strength of 1500 psi (10,342.5 kPa) at 28 days.

Two initial gradation tests for each type of embedment, fill, embankment, engineered fill, aggregate base, structure and trench backfill material and one additional gradation test for each additional 1000 tons (909,091 kg) of each material.

2.2.14 Tests. All tests to ensure that embedment, fills and embankments, engineered fill, structure and trench backfill materials, and other fills and their placement comply with specified requirements shall be made by an independent testing laboratory at the expense of the Contractor. The following tests will be required as directed by Engineer:

Two moisture-density (Proctor) tests in accordance with AASHTO T-180 modified Method C, the MDOT cone density method or AASHTO T-99 "one-point" test as appropriate for each type of embedment, fill, aggregate base, embankment, engineered fill, structure and trench backfill material proposed, except for granular embedment material.

For pipelines, in-place field density tests at average intervals of 1,000 feet (304.8 meter) along the trench.

For area fills and embankments an in-place field density test for each 500 cubic yards (383 cu meters) of material placed.

For engineered fill and structure backfill, in-place field density and moisture tests for each 300 cubic yards (229.4 cu m) of material placed.

PART 3 - EXECUTION

3.1 INSPECTION. Locate off-site stockpile areas for suitable excavated material and borrow. Do not stockpile excavated material or borrow on site without approval of Engineer. Select disposal areas for unsuitable excavated material and dispose of in accordance with local laws and ordinances.

Carry out program of pre-excavation, excavation, dewatering, sheeting, and bracing in such manner as to eliminate undermining or disturbing buried utilities, conduits, foundations of existing structures, or of work previously completed under this contract.

Excavate to widths that give suitable room for building structures or laying and jointing piping; furnish and place all sheeting, bracing, and supports; do all pumping, and draining and render bottom of excavations firm and dry and acceptable in all respects.

Make excavations and construct embankments and backfill excavations to the lines and grades indicated on the Drawings and compact to the specified density or as indicated on the Drawings.

Provide suitable and safe bridges and other crossings where required for accommodation of travel, and to provide access to existing facilities during construction, and remove said structures thereafter.

3.2 PREPARATION. Establish the extent of excavation by area and elevation; designate and identify datum elevation. Identify, flag and stake known underground, surface and aerial utilities. Set out all required lines and levels.

All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, snags, bark, and other objectionable materials and debris. Cut trees, stumps, and stubs to be cleared, except where clearing done by machinery, as close to ground surface as practicable, but no more than 6 inch (15.2 cm) above ground surface for small trees and 12 inches (30.5 cm) for larger trees.

Remove existing signs, posts, catch basin frames and grates, and manhole frames and covers, within construction path unless directed otherwise. Store at site designated by Engineer.

The Contractor shall prevent any damage to pipes, conduits, wires, cables and structures above or below ground. No land monuments or property markers shall be damaged or removed without the prior authorization of the Engineer.

All holes remaining in the project area after the completion of clearing and grubbing operations shall have the sides broken down or leveled if necessary to flatten out the slopes. Holes, depressions, ruts and other imperfections shall be refilled with acceptable material and compacted in layers to the density specified under Earthfills and Embankments. The same procedure shall apply to all holes remaining in excavation areas where the depth of the holes exceeds the depth of the required excavation.

Subgrades for fills and embankments shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. Remove stumps, roots larger than 3 inch (7.6 cm) in diameter to a depth of 12 inch (30.5 cm), and roots larger than 1/2 inch (1.3 cm) in diameter to a depth of 6 inch (15.cm). Measured depths from existing ground surface or proposed finished grade, whichever is lower. Proof roll or compact subgrade to density requirements for backfill material. All waste materials shall be removed from the site and disposed of in accordance with all applicable laws, ordinances, rules and regulations by and at the expense of the Contractor. Burning of materials at the site will not be permitted. Taking loam from site is not permitted.

3.3 PERFORMANCE.

3.3.01 Stripping. Remove heavy growth of grass, sod, decayed vegetation and other unsuitable material from the areas to be stripped.

3.3.02 Conservation of Topsoil. Topsoil to a depth of 6 inches (15.2 cm) within the areas to be stripped shall be removed and stockpiled in a convenient area as approved. Topsoil stripped and stockpiled shall be without admixture of subsoil, free of plants and their roots, stones and other undesirable material. Topsoil suitable for Lawns shall be stored separately from other excavated materials.

3.3.03 Excavation. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

Carry out no dewatering and no pre-excavation or excavation below the existing ground-surface until geotechnical instrumentation has been installed and base line data obtained.

Excavate all materials encountered and existing below grade obstructions as required to allow construction of the proposed building structures, utilities and site work as shown on Drawings and as hereinafter specified. Remove any rocks or boulders encountered less than 1/2 cubic yard (0.4 cu m) in volume.

Excavate to levels shown for footings, pile caps and grade beams. Excavate to 3 inches (5.1 – 7.6 cm) below bottom of slabs for mud mat unless otherwise indicated. Excavate as required to provide working clearance and to allow adequate inspection for structures. Excavate to subgrades specified herein below outside of building. Excavate in a manner, which minimizes the disturbance of the pre-excavation slopes.

Cut out soft areas of subgrade not readily capable of compaction. Backfill with approved fill materials and compact to density equal to requirements for subsequent backfill material.

Make no excavations to the full depth indicated when freezing temperature may be expected, unless the footings or slabs can be placed on non-frozen soil after the excavation has been completed. Protect the bottom of excavation from frost if placement of concrete is delayed. Should protection fail, remove frozen materials and replace with concrete or bank-run gravel, as directed, at no additional cost to Owner.

Where excavations may expose existing foundations to potential frost heave, provide adequate protection to prevent freezing below foundations.

Provide all measures necessary to ensure the safety of workers and of the existing facilities at all times during construction and in accordance with applicable City, State and Federal regulations.

There may be pipes, drains, and other utilities in certain locations. These have been indicated on the Drawings to the extent known, however the completeness or accuracy of the information given is not guaranteed.

3.3.04 Classification Of Excavated Materials. No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

3.3.05 Preservation Of Trees. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by the Owner. The Contractor shall be responsible for damages, outside these areas. Trees left standing shall be adequately protected from permanent damage by construction operations.

Protection for trees and shrubs shall include fences and boards lashed to trees to prevent damage by construction operations. No trees and shrubs shall be trimmed without prior permission of the Engineer. No material that needs to be stockpiled shall be placed against any trees. Only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract and such removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner if such, in his opinion, are too close to the work to be maintained or have become damaged due to the Contractor's operations.

3.3.06 Protection Of Existing Structures. Support and protect from damage all existing pipes, poles, wires, fences, pavement, curbing, walkways, property line markers, bench marks, monuments and other structures, not indicated for relocation which the Engineer decides must be preserved in place without being temporarily or permanently relocated. Should such items be damaged, restore without compensation therefore, to at least as good condition as that in which they were found immediately before the work was begun.

3.3.07 Relocation And Replacement Of Existing Structures. Whenever the Contractor encounters certain unforeseen or unknown conditions pertaining to existing structures and is so ordered in writing, he shall do the whole or such portions of the work as he may be directed, to change the location of, remove and later restore, or replace such structures, or to assist the Owner thereof in so doing.

Use care to avoid damage to materials when removing existing pipes or other structures.

The structures to which the provisions of the preceding two paragraphs apply include pipes, wires, and other structures which meet all of the following:

Are not indicated on the Drawings or otherwise provided for.

Encroach upon or are encountered near and substantially parallel to the edge of the excavation.

In the opinion of the Engineer will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced.

Remove fences that interfere with the Contractor's operations, and (unless otherwise specified) later restore them to at least as good condition as that in which they were found immediately before the work was begun, without additional expense to the Owner. Contractor shall restore fences promptly and shall not leave restoration until the end of the construction period.

3.3.08 Care And Restoration Of Property. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces when treads or wheels of which are so shaped as to cut or otherwise injure such surfaces.

Restore all surfaces which have been injured by the Contractor's operations, to a condition at least equal to that in which they were found immediately before work commenced. Use suitable materials and methods for such restoration.

Contractor shall restore existing property or structures promptly and shall not wait until the end of the construction period.

3.3.09 Unauthorized Excavation. Except where otherwise authorized, indicated, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced, by and at the expense of the Contractor, with lean concrete. Unauthorized excavation in other locations shall be filled with approved fill materials and compacted to the specified density for that type of fill.

3.3.10 Dust Control. During progress of work, conduct operations and maintain area of activities, including sweeping and sprinkling of streets at least once in the morning and once in the afternoon or more if necessary, so as to minimize the creation and dispersion of dust. Furnish and spread calcium chloride material, as directed, if Engineer decides that it is necessary to use calcium chloride for more effective dust control.

3.3.11 Blasting. Blasting or other use of explosives for excavation will not be permitted.

3.3.12 Dewatering. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Provide and maintain ample means and devices (including spare units kept ready for immediate use in case of breakdowns) to intercept and/or remove promptly and dispose properly of all water entering trenches and other excavations.

Coordinate construction operations to minimize duration and extent of dewatering required.

Provide all equipment, tools, materials and labor required for dewatering operations for temporary control of artesian water in the underlying bedrock. Dewatering may be required in conjunction with grouting or other suitable methods necessary to seal leakage of artesian water. Leakage of artesian water may occur if rock grouting does not completely seal the rock or in the event that piles or sheeting penetrate the hardpan sufficiently to cause leakage.

Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations 2 feet (61.0 cm) or more below the bottom of the excavation.

Modify dewatering operation if geotechnical instrumentation indicates movement of structures, sheeting or embankments.

Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.

The Contractor shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

3.3.13 Sheeting Shoring. Except where banks are cut back on a stable slope, excavations for structures and trenches shall be supported as necessary to prevent caving or sliding.

Provide shoring, including steel sheet piling, soldier beams and wood lagging or other protective measures, as may be necessary to protect adjacent structures, facilities and utilities. Contractor shall be responsible for the adequacy of the design installation and effectiveness of shoring and other protective methods utilized and repair damage resulting from failure to take adequate measures for protection of persons and adjacent property (including but not limited to land, structures, facilities, pavements, utilities and grades). Remove shoring when no longer required.
Prior to installation, make every effort to determine the presence of existing underground conditions not indicated. If unknown services or obstructions are discovered the contractor shall notify the Engineer before proceeding.

Trench sheeting may be removed only if the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting. Trench sheeting shall not be pulled after backfilling. With the concurrence of the Engineer, sheeting shall be left permanently in the trench when placing gravity sewers, force mains, water distribution mains, or transmission lines. Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

If Engineer of the opinion that at any point the shoring, bracing or excavation support systems are inadequate or unsuited for the purpose, resubmission of design calculations and working drawings for that point may be ordered, taking into consideration the observed field conditions. If the new calculations show the need for additional shoring and bracing, it should be installed immediately.

Steel sheet piling shall be furnished, installed, and left in place as required to limit the extent of excavations for the deeper structures and necessary backfill under adjacent shallower structures, and to protect adjacent structures and facilities from damage due to excavation and subsequent construction.

Drive sheeting ahead of excavation to avoid loss of material from behind sheeting. Avoid trimming behind face where sheeting will be driven, if excavating below sheeting. Prevent voids outside of sheeting. Immediately fill any voids that develop with sand, and compact.

Cut off sheeting and bracing at specified elevations, as directed by Engineer, or as indicated on the Drawings. Sheeting and bracing shall not be left in place in such a way as to endanger construction or other structures. Immediately backfill all voids left or caused by withdrawal of sheeting. Use suitable materials and compacting methods.

3.3.14 Stabilization. Subgrades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

3.3.15 Compaction Equipment. Provide sufficient equipment units of suitable types to spread, level, and compact fills promptly upon delivery of materials.

Contractor may use any compaction equipment or device which he finds convenient or economical, but the Engineer retains the right to disapprove equipment which, in his opinion, is of inadequate capacity or unsuited to character of material being compacted.

3.3.16 Structure Foundation Preparation. Excavation: Excavation below proposed non-pile-supported concrete structures shall consist of removing all existing fill to the level of natural soils. Excavation shall be performed using methods and equipment that prevent disturbance of the bearing materials. Should bearing materials become disturbed due to excavation operations, they shall be recompacted, removed or stabilized to produce a firm, dense and thoroughly compacted and consolidated subgrade.

Excavations of unsuitable materials shall extend beyond the edge of the footing a distance equal to the depth of overexcavation below the bottom of the footing. In no case, however, shall proposed excavations undermine existing foundations. Foundations and slabs of existing structures shall be positively supported by means suitable to prevent damage to structures.

Subgrade Preparation: Subgrades below footings and slabs shall be compacted to at least 95 percent of the maximum dry density and moisture conditioned to between minus two (-2) and plus two (+2) percent relative to the optimum moisture content or as indicated on the Drawings.

Replacement Materials: Materials used to replace existing fills shall meet the quality and classification of engineered fill. Engineered fill shall be placed and compacted as specified for fills and embankments.

3.3.17 Construction Requirements. Subgrades and fills shall be periodically wetted to prevent desiccation. Should soils become desiccated, they shall be removed and replaced; soaked or; scarified, moisture conditioned and recompacted as specified herein to provide a subgrade within the specified moisture and compaction limits. Any soft areas which develop due to excessive moisture increase shall be dried out or removed prior to placing additional lifts or concrete.

3.3.18 Earthfills And Embankments. Fills and embankments shall be constructed to the lines and grades indicated on the drawings. To the maximum extent available, excess suitable material obtained from structure and trench excavation shall be used for the construction of fills and embankments. Additional material shall be provided as required.

All material placed in fills and embankments shall be free from rocks or stones larger than 6 inches (15.2 cm) in their greatest dimension, brush, stumps, logs, roots, debris, and other organic or deleterious materials. No rocks or stones shall be placed in the upper 18 inches (45.7 cm) of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so that they do not interfere with proper compaction.

Subgrade Preparation: After preparation of the fill or embankment site, the subgrade shall be leveled and rolled so that surface materials of the subgrade will be as compact and well bonded with the first layer of the fill or embankment as specified for subsequent layers.

Placement and Compaction: All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 8 inches (20.3 cm) in uncompacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as required and thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to 95 percent of maximum density at a moisture content in the range of 2 percent below to 2 percent above the optimum moisture content, or as indicated on the Drawings. If the material fails to meet the density specified, compaction methods shall be altered.

Wherever a trench is to pass through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than 12 inches (30.5 cm) above the top of pipe elevation before the trench is excavated.

Earthfills and Embankments Over Reservoir or Basin Roof Slabs: Earthfills and embankments over reservoir or basin roof slabs shall be placed and compacted by using methods that will not damage or overload the structure; compaction in addition to that attained by placement operations will not be required. Rubber-tired equipment shall be used insofar as possible. Individual items of equipment operated on reservoir or basin roof slabs shall not have loaded weight in excess of 14,000 pounds (6342 kg) and shall be so operated that no impact loads are imposed on the structure. Fill material shall not be piled on the roof slab to a depth greater than 12 inches (30.5 cm) above finished grade elevation. Fill construction shall begin at the walls, and construction equipment shall operate on a layer of fill material at least 12 inches (30.5 cm) deep. Special care shall be taken to avoid damaging or disturbing any roofing membrane, tile drains, or granular fill material.

3.3.19 Granular Fills. Granular fills shall be provided where indicated on the drawings. Granular fills shall be placed on suitably prepared subgrades and compacted by vibration. Granular fills shall be compacted to not less than 95 percent of maximum density as determined by the MDOT cone density method or as indicated on the Drawings.

Where granular fills are to be covered with concrete, the top surface shall be graded to the required subgrade and covered with polyethylene film as specified in Master Specification Section 02750, Concrete Pavement.

3.3.20 Roadway Excavation. Excavation for roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the drawings and shall include the excavation of all unsuitable material from the subgrade. Provide and maintain, at all times during construction, adequate means and devices which will promptly remove and dispose of all water from any source entering any area of the work. Dewater by means which will ensure dry work areas and preservation of the final lines and grades. After shaping to line, grade, and cross section, the subgrade shall be compacted to a depth of at least 6 inches (15.2 cm) to 95 percent of maximum density at a moisture content in the range of 2 percent below to 2 percent above the optimum moisture content, or as indicated on the Drawings. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material. Excavated material unsuitable for reuse shall be disposed of by the Contractor offsite. After removal of unsuitable material, where possible, 6 inch (15.2 cm) perforated underdrain pipe shall be placed from the low point of excavated area to a natural drainage course, ditch or storm sewer structure. The excavated area shall then be backfilled with an approved porous material. Where an outlet for underdrain pipe is not available and the surrounding earth is impervious, the backfill shall be made with clay free from silt and topsoil.

3.3.21 Trench Work. No more trench shall be opened in advance of pipe laying than is necessary to expedite the work. One block or 400 feet (121.9 m), whichever is the shorter, shall be the maximum length of open trench on any line under construction. Except where tunneling is indicated on the drawings, is specified, or is permitted by the Engineer, all trench excavation shall be open cut from the surface.

The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of Master Specification Section 02620, Water Main Services.

Where pipe grades or elevations are not definitely fixed by the contract drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 5 feet (1.5 m). Greater pipe cover depths may be necessary on vertical curves or to provide adequate clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation, except where future surface elevations are indicated on the drawings.

Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment. Minimum trench widths shall be as follows:

MINIMUM TRENCH WIDTHS

Nominal Pipe Size (inches)	Minimum Trench Width (inches)	Minimum Sidewall Clearance (inches)
Less than 27	Pipe OD plus 24	12
27 through 60	Pipe OD plus Nominal pipe size	ID/2
Greater than 60	Pipe OD plus 70	30
OD = Outside diameter (or span) of conduit. ID = Inside diameter (or span) of conduit.		

Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances, which will be required to the trench excavation or the trench protective system.

Bell holes shall provide adequate clearance for tools and methods used in installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits.

Where, for any reason, the width of the lower portion of the trench, as excavated at any point, exceeds the maximum permitted in the foregoing table, pipe of adequate strength, special pipe embedment, or concrete arch encasement, as required by loading conditions and with the concurrence of the Engineer, shall be furnished and installed by and at the expense of the Contractor.

Whenever unsuitable or unstable soil conditions are encountered, trenches shall be excavated below grade to undisturbed and the trench bottom shall be brought to grade with suitable material.

3.3.22 Mechanical Excavation. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

Where determination of the exact location of pipe or other underground structure is necessary for doing the work properly, the Contractor may be required to excavate test pits to determine such locations. When such test pits may be properly considered as incidental to other excavation, the Contractor will receive no additional compensation, the work being understood to be included as a part of the excavation.

Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that the rough trench excavation bottom elevation can be controlled, and that trench alignment is such that pipe, when accurately laid to specified alignment, will be centered in the trench with adequate sidewall clearance. Undercutting the trench sidewall to obtain sidewall clearance will not be permitted.

3.3.23 Pavement Cutting. Cuts in pavements shall be no larger than necessary to provide adequate working space for proper installation of pipe and appurtenances. Cutting shall be by saw cutting in a manner which will provide a clean, flat edge along each side of the trench and along the perimeter of cuts for structures.

Pavement over trenches excavated for pipelines shall be removed so that a shoulder not less than 6 inches (15.2 cm) in width at any point is left between the cut edge of the pavement and the top edge of the trench. Trench width at the bottom shall not be greater than at the top and no undercutting will be permitted. Pavement cuts shall be made to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.

Pavement removal for connections to existing lines or structures shall not exceed the extent necessary for the installation.

Pavement shall be removed and restored between existing construction or contraction joints, located at or outside the limits of excavation at intersecting streets or roads, except as otherwise shown or specified.

Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced. Where the trench crosses drives, walks, curbs, or other surface construction, the surface construction shall be removed and subsequently replaced between existing joints or between saw cuts as specified for pavement.

Contractor shall excavate below the underside of the pipe, except where otherwise required, to provide for the installation of granular embedment.

3.3.24 Pipe Embedment. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on the Drawings and to the following supplementary requirements.

Embedment material shall contain no cinders, clay lumps, or other material which may cause pipe corrosion. Embedment below the bottom of the pipe to just above the top of pipe shall conform to the applicable class below:

> Class A Arch Encasement – Is not required unless improper trenching or unexpected trench conditions require its use as determined by Engineer.
>
> Class B Bedding –Shall be used for all steel, pretensioned concrete, profile wall HDPE, PVC, ABS, FRP, and vitrified clay pipelines, and for all other pipelines not otherwise specified.
>
> Class C Bedding – Shall be used for all reinforced concrete, prestressed concrete, and ductile iron pipelines.

Embedment for Ductile Iron, Steel, FRP, and PVC Pipelines: Granular embedment for ductile iron, coal tar coated steel, FRP, and PVC pipelines shall be pea gravel or crushed rock with rounded or subrounded particles; crushed rock with sharp edges which could cause significant scratching or abrasion of the pipe or damage to the polyethylene tube protection shall not be used. Inundated sand may be used for granular embedment in locations where the use of water will cause no damage to adjacent property and where it can be placed and properly compacted without damage to the pipe.

Placement and Compaction: Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.

After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.

Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

Class C embedment shall be compacted to the top of the pipe in all areas where compacted backfill is specified.

Each lift of granular embedment material shall be vibrated with a mechanical probe type vibrator during placement to ensure that all spaces beneath the pipe are filled. Each lift of embedment material shall be compacted with a platform type vibrating compactor to at least 95 percent of maximum density or as indicated on the Drawings.

Groundwater Barrier: Continuity of embedment material shall be interrupted by low permeability groundwater barriers to impede passage of water through the embedment. Groundwater barriers for sewer lines that contain manholes with cast-in-place bases shall be compacted soil around each manhole, meeting soil classification GC, SC, CL, or ML-CL, compacted to 95 percent of maximum density. Material may be finely divided, suitable job excavated material, free from stones, organic matter, and debris.

Groundwater barriers for sewer lines that contain manholes with precast (developed) bases and for all other pipelines shall be three layers of 6 mil polyethylene film, extending the full depth and width of granular material, and spaced not more than 400 feet (121.9 m) apart.

3.3.25 Trench Backfill. All trench backfill above pipe embedment shall conform to the following requirements.

A layer of backfill material not more than 8 inches (20.3 cm) deep may be placed over concrete arch encasement or concrete reaction blocking after the concrete has reached its initial set, to aid curing. No additional backfill shall be placed over arch encasement or blocking until the concrete has been in place for at least 3 days.

Compacted Trench Backfill: Will be required for the full depth of the trench. Backfill and compact trenches only after pipe or other appurtenances have been inspected, tested and locations of pipes and appurtenances have been recorded.

The top portion of backfill beneath established lawn areas shall be finished with at least 4 inches (10.2 cm) of topsoil corresponding to, or better than, that underlying adjoining lawn areas.

With exception of beneath pavements and roadways, at the option of the Contractor, compacted trench backfill may be suitable job excavated material or graded gravel, as described below.

Job Excavated Material: May be used for compacted backfill when the job excavated material is finely divided and free from debris, organic material, cinders, any corrosive material, and stones larger than 3 inches (7.6 cm) in greatest dimension. Masses of moist, stiff clay shall not be used. Job excavated materials shall be placed in uniform layers not exceeding 8 inches (20.3 cm) in uncompacted thickness. Each layer of material shall have the best possible moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as required and thoroughly mixed to ensure uniform moisture content and adequate compaction. Increased layer thickness may be permitted for noncohesive material if the Contractor demonstrates to the satisfaction of the Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe. Job excavated material shall meet the requirements specified for engineered fill and shall be compacted to 95 percent of maximum density at near the optimum moisture content, or as indicated on the Drawings.

Where conduits are placed within the zone of influence of proposed or existing roadways and pavements, compacted trench backfill shall consist of graded gravel or other material approved by the Engineer.

Graded Gravel: Gravel backfill shall be deposited in uniform layers not exceeding 12 inches (30.5 cm) in uncompacted thickness. The backfill shall be compacted with a suitable vibratory roller or platform vibrator to at least 95 percent of maximum density, or as indicated on the Drawings.

3.3.26 Structure Backfill. The quality and moisture content of materials for backfill around and outside of structures shall conform to the requirements for materials used for earthfills and embankments. Before backfilling against walls, the permanent structures (including basement floor slabs) must be completed and the concrete shall have attained its 28-day design strength required to resist backfill pressures without damage. Temporary bracing will not be permitted except by written permission from the Engineer. When filling on both sides of a wall or pier, place fill simultaneously on each side. Correct any damage to the structure caused by backfilling operations at no cost to Owner. Backfill materials shall be deposited in layers not to exceed 8 inches (20.3 cm) in uncompacted thickness and shall be compacted to at least 95 percent of maximum density at a moisture content in the range of 2 percent below to 2 percent above the optimum moisture content, or as indicated on the Drawings. Compaction of structure backfill by rolling will be permitted, provided the desired compaction is obtained and damage to the structure is prevented. No backfill shall be deposited or compacted in water.

Structure Backfill placed adjacent to foundation walls shall be placed within a zone defined by a line starting at the base of the wall and sloping upward at a ratio of 1 horizontal to 1 vertical.

Particular care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a trench is to pass through structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches (30.5 cm) above the top of pipe elevation before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

3.3.27 Drainage Maintenance. Trenches across roadways, driveways, walks, or other traffic ways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the traffic way, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by the Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed, and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

3.3.28 Protection Of Trench Backfill In Drainage Courses. Where trenches are constructed in ditches or other watercourses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1 percent, ditch checks shall be installed. Unless otherwise indicated on the drawings, ditch checks shall be concrete. Ditch checks shall extend at least 2 feet (61 cm) below the original ditch or watercourse bottom for the full bottom width and at least 18 inches (45.7 cm) into the side slopes, and shall be at least 12 inches (30.5 cm) thick.

3.3.29 Final Grading and Placement of Topsoil. After other outside work has been finished, and backfilling and embankments completed and settled, all areas that are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches (10.2 cm). Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.

Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3.3.30 Disposal Of Excess Excavated Materials. Insofar as needed, suitable excavated materials shall be used in fills and embankments.

All unused suitable excess excavated materials, together with all debris, stones, logs, stumps, roots, and other unsuitable materials, shall be removed from the site and disposed of by, and at the expense of, the Contractor.

3.3.31 Resodding. All established lawn areas cut by the line of trench or damaged during the work shall be resodded, after completion of construction, to the complete satisfaction of the Engineer. All sod used shall be the same type as removed or damaged, shall be best quality, and, when placed, shall be live fresh growing grass with at least 1-1/2 inches (3.8 cm) of soil adhering to the roots.

All sod shall be procured from areas where soil is fertile and contains a high percentage of loamy topsoil and from areas that have been grazed or mowed sufficiently to form a dense turf.

Sod shall be transplanted within 24 hours from the time it is harvested, unless stacked at its destination in a suitable manner. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing. In no event shall more than 1 week elapse between cutting and planting.

Before placing sod, all shaping and dressing of the areas shall have been completed. After shaping and dressing, commercial fertilizer of a type acceptable to the Engineer shall be applied uniformly in the manner and amounts recommended by the manufacturer, and harrowed lightly. Sodding shall follow immediately.

All sodding shall be done during the period from March 15 to October 1, unless written permission is given by the Engineer to extend the planting season.

3.3.32 Settlement. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.

The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from the Engineer.

3.4 FIELD QUALITY CONTROL. All fill materials will be subject to quality control testing. A qualified laboratory will be selected and paid by the Contractor to perform tests on materials. Test results and laboratory recommendations will be made available to Engineer and Contractor.

Provide samples of each fill material from the proposed source of supply. Allow sufficient time for testing and evaluation of results before material is needed (a minimum of two weeks). Submit samples from alternate source if required.

Engineer will be sole and final judge of suitability of all material.

The laboratory will determine maximum dry density at optimum water content in accordance with AASHTO T-180 Modified Method C (for density) and AASHTO T-99 (for optimum moisture) or AASHTO T-99 “One-Point” Test as applicable for the materials to be used.

Tests of material as delivered may be made from time to time. Materials in question may not be used pending test results. Remove rejected materials and replace with new approved material.

End of Section

SECTION 02221

TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.1 SCOPE. Section includes excavating, backfilling and compacting trenches for utilities and appurtenances.

1.2 GENERAL. Furnish all labor, materials, equipment and incidentals required to perform all trenching, backfilling and compacting specified. Perform prompt cleanup, removal, as well as safe and proper disposal of all waste material resulting from the work herein. Perform prompt and proper removal, salvage, protection, storage and turnover to the Engineer, when requested, of all surplus useable material resulting from the work herein. Remove and restore sidewalks, curbs, driveways and roadways in the trench path.

1.2.01 Governing Standards. Do Work in accordance with the Michigan Department of Energy, Labor and Economic Growth Construction Standards Part 9:"Excavation, Trenching, and Shoring".

The MDOT Standard Specifications.

1.3 QUALITY ASSURANCE.

1.3.01 Tolerances. Cut out soft areas of subgrade not capable of compaction in place. Backfill with sand and compact to 95 percent of maximum density or as shown on the Drawings.

1.4 SUBMITTALS. Submit samples of all proposed materials. Provide accurate record in formation for completed construction.

PART 2 – PRODUCTS

2.1 MATERIALS. Granular backfill material shall be crushed rock, sand or gravel; shall be free from dust, clay, and trash; and shall be graded 1 ½ inch (3.9 cm) to No. 4 as defined in ASTM C33. Refer to the drawings for locations of specific backfill materials to be placed.

2.1.01 Bank-Run Gravel. Use Michigan Department of Transportation (MDOT) Granular Material for Fill, Class I or such other sizes as may be approved. Fill may be approved excavated material or can be obtained from approved natural deposits and unprocessed except for the removal of unacceptable material and stones larger than the maximum size permitted. Material shall be free from vegetation and substantially free from loam and other organic matter, clay, other fine or harmful substances, frost, snow, ice, and aggregations of frozen soil particles. Compact thoroughly by means of suitable power-driven tampers or other power-driven equipment to density indicated on the Drawings.

2.1.02 Class II Granular Material. Approved sand, gravel, crushed stone, blast-furnace slag or combination thereof, with 100 percent passing 3 inch (7.6 cm) sieve, 60 to 100 percent passing 1 inch (2.5 cm) sieve, 0 to 30 percent passing No. 100 sieve, and loss by washing not to exceed 7 percent, per MDOT Standard Specifications for Granular Materials for Fill and Subbase.

2.1.03 Select Borrow. Use MDOT Granular Material for Fill, Class III or such other sizes as may be approved. Maximum stone size is 6 inch (15.2 cm) and material shall be well-graded throughout entire size range. Borrow free from roots, leaves, and other organic materials. Borrow shall also be free of ice or frost and no aggregations of frozen soils particles. Moisture content of borrow shall be within plus or minus 3 percent optimum moisture content at the borrow source. Compact thoroughly by means of suitable power-driven tampers or other power-driven equipment to the density indicated on the Drawings.

2.1.04 Aggregate Base Material. Aggregate base for aggregate surfaced or paved surfaces shall meet MDOT Standard Specification for 21AA or such other sizes as may be approved.

2.1.05 Graded Gravel. Gravel for compacted trench backfill shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
1 inch (2.5 cm)	100
¾ inch (1.9 cm)	85 – 100
3/8 inch (9.5 mm)	50 – 80
No. 4	35 – 60
No. 40	15 – 30
No. 200	5 – 10

The gravel moisture shall contain no clay lumps or organic matter. The fraction passing the No. 4 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5. An alternate material may be used if approved by the Engineer.

2.1.06 Select Excavated Material. Select excavated material shall be of a type, which can be compacted to the density specified. Such material shall be free from rubbish or debris, frozen lumps, boulders, or concrete fragments, sod, organic material, tree roots, stumps, branches or other timber. Select excavated material considered suitable for backfill shall be sand, sand-gravel mixture, clean clay, or a combination thereof.

Generally, blue clay, foundry sand, organic material, and slag shall not be considered a suitable backfill material. Material used for backfill that cannot be compacted to the degree specified shall be removed, and replaced with suitable material. Legally dispose of any material removed.

2.1.07 Sand. Clean yellow sand Type 2NS in accordance to the Aggregation section of the current MDOT Standard Specifications for Construction.

2.1.08 Concrete. Conforming to cast-in-place concrete requirements with a compressive strength of 3000 psi (20,684.3 kPa).

2.1.09 Lean Concrete. Lean concrete shall be a mixture of Portland cement, aggregate and water, having a minimum compressive strength of 1500 psi (10,342.5 kPa) at 28 days.

PART 3 - EXECUTION

3.1 PREPARATION. Identify required lines, levels, contours, and datum locations. Protect plant life, lawns, and other features remaining as a portion of final landscaping. Protect bench marks, existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic. Maintain and protect above and below grade utilities, which are to remain

Notify the Engineer a minimum of 30 working days prior to the work where survey monuments will be disturbed so they may be referenced, then relocated. Provide the referencing and the relocation. The referencing and relocation shall be provided in accordance with the requirements and directions of the authority and agency having jurisdiction.

3.2 PERFORMANCE.

3.2.01 Excavation. Remove all materials of whatever nature necessary to install the required utilities and appurtenances; paving will be cut accurately to correct lines. Paving maybe sawcut where practical. Suitable protection and dewatering will be provided to maintain trenching and excavation dry and safe throughout the construction operations. The Contractor will see that traffic is not obstructed during excavation, trenching, backfilling and compacting operations. The trenches will be sufficiently wide to enable installation and inspection of pipes. Bell and spigot pipe joints will be hand trimmed and loose matter will be removed.

Remove lumped sub soil, boulders and rocks up to ½ cu yd (0.4 cu m) from excavated area and correct with compacted backfill as specified or authorized excavation or replace with lean concrete as directed.

3.2.02 Trenching. Excavation shall be dug so that the pipe can be placed and jointed properly as applicable. The trench shall be made so that the proposed utility pipe can be laid to the alignment and depth as shown on the Drawings. The excavation shall not be more than two feet wider at the bottom than the outside diameter of the pipe or structure. If there is no interference with construction, or adjacent property, and if soil permits, the Contractor at his own expense shall be permitted to slope the side walls of the excavation starting at a point 2 feet (61.0 cm) above the top of pipe.

The trench shall be excavated to the depth required so as to provide a uniform and continuous bearing and support for the pipe or structure on bedding materials at every point between joints, except where pipe slings or other lifting tackle are withdrawn.

Where excavation exposes subsurface materials at the bottom of the trench that are in a loose or soft state, the Contractor shall be advised to excavate to a depth where suitable material is encountered, as directed by the Engineer.

Where the bottom of the trench has been excavated by mistake to a greater depth than required, the Contractor shall refill this area using approved material. No additional compensation shall be given to the Contractor. Refilling with earth to bring the bottom of the trench to the proper grade will not be permitted.

Excavation within 2 feet (61.0 cm) of existing utilities shall be governed by specifications of the Owner of the respective utility. The Contractor shall obtain these specifications and follow the same at no extra cost.

3.2.03 Trenching in Advance of Pipe Laying. No more trench shall be opened per sequence phase than is indicated in the Drawings until concrete is placed over previous opened trench areas. All trench excavation shall be open cut from the surface.

3.2.04 Alignment, Depth, and Width. Trench excavation shall follow the alignment of the proposed utilities and appurtenances.
The Contractor shall be responsible for making careful and accurate measurements and for constructing all work to the lines and grades as shown on the Drawings.

As an alternative means of establishing alignment and grade, a "Laser-Beam" instrument may be utilized with a competent operator.

3.2.05 Location of Pipe Lines. The location and approximate depths of the proposed pipe lines are shown on the Drawings. The Engineer reserves the right to make changes in lines, grades, and depths of pipelines and manholes when such changes are necessary. Excavation and trenching shall be adequately shored and braced. Adjoining ground shall be prevented from sliding or settlement. Existing improvements of any kind shall be fully protected from damage.

Contractor shall bear all responsibility and expenses for any damage and injury, and effect all necessary repairs or reconstruction. Comply with all applicable requirements of the Michigan Department of Energy, Labor and Economic Growth Construction Standards.

Concrete sidewalks within excavation and trenching areas, or within 4 feet (1.2 m) and approximately parallel to excavation and trenching areas, or within other boundaries established by the local jurisdiction, shall be removed, disposed and replaced.

3.2.06 Utilities. Explore, determine and provide the exact locations of all underground utilities and structures sufficiently in advance of excavation to allow adjustment of alignment and elevation.

Provide for having all underground utilities located by the appropriate and responsible utility companies or other agencies in advance of excavation.

Coordinate this activity outside of Owner’s facilities by calling MISS DIG, at 1-800-482-7171 at least three working days in advance of excavation.

Provide adjustments of conduit and/or cable alignment and elevation where the exploratory work indicates the need.

Excavation around utilities and other work under or adjacent to utilities shall not interfere with their safe operation and use. Probe carefully to determine the exact location of utility, and hand excavate where necessary to avoid damage.

In the event of damage incurred during construction to such utilities, structures or property, immediately notify the Engineer, owners and other appropriate authorities, and provide immediate suitable and satisfactory repairs.

Provide all direct and related utility costs and services to protect, maintain and/or relocate utilities within the areas and encroachment limits of the excavation and trenching, including all the work to re-lay utilities to new and/or existing grade lines. Also provide all direct and related utility costs and services to support utilities within or near by the areas and encroachment limits of the excavation and trenching, including utilities that do not require re-laying or altering.

3.2.07 <u>Sheeting and Bracing</u>. Sheeting and bracing of all excavations shall conform to the latest statures of the State of Michigan governing safety of workers in the construction industry. When necessary, in the opinion of the Engineer or Contractor, adequate sheeting and bracing shall be installed to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines and utilities. Any damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be resized at the Contractor's expense.

Sides of trenches in unsuitable, loose or soft material, 5 feet (1.5 m) or more in depth, shall be shored, sheeted, braced, sloped, or otherwise supported by means of sufficient strength to protect employees working within them.

Sheeting requirements: Where excavations are made with vertical sides which require supporting, the sheeting and bracing shall be of sufficient strength to sustain the sides of the excavations and to prevent movement which could in any way injure the work, or adjacent structures, or diminish the working space sufficiently to delay the work. Special precautions shall be taken where there is additional pressure due to the presence of other structures.

It shall be the Contractor's responsibility to select sheeting and bracing of sufficient dimensions and strength to adequately support the sides of trenches and excavations. The Contractor shall submit details of the sheeting and bracing he proposes to use to the Engineer for review.

Timber sheeting shall conform in quality to select structural Douglas Fir lumber and shall be sound, live timber, free from sap, large checks, shakes, loose or decayed knots, worm holes, and other imperfections which may impair its strength or durability.

In wet excavation, grooved sheeting shall be used to prevent passage of soil. Any voids between sheeting and face of excavation shall be filled with suitable material rammed in place.
Sheeting and bracing shall be removed before the completion of the work, unless otherwise directed in writing by the Engineer. Sheeting which is left in place shall be cut off eighteen 18 inches (45.7 cm) below the original ground surface or as directed by the Engineer. Untreated wood will not be allowed to be left in place.

3.2.08 <u>Bedding and Compaction</u>. For proper bedding bring backfill up evenly on both sides of pipe or conduit to a height of 4 inches (10.2 cm) above the top of pipe or conduit. Thoroughly compact before additional fill is placed. Provide a minimum of 4-inches backfill between pipe or conduits and the bottom and sides of the trench. Bedding backfill shall be sand or as indicated on the Drawings.

Compact bedding by impact, vibration, or a combination of these methods. Bedding compaction methods and equipment are subject to the approval of the Engineer.

3.2.09 Backfill and Compaction Above Bedding. Backfill trenches to contours and elevations with unfrozen fill materials. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces. Employ a placement method that does not disturb or damage utilities in trench.

Backfill shall be graded gravel Class I or Class II granular fill for area within influence of paved areas or as indicated on the Drawings or approved by the Engineer. Backfill shall be Class III or select excavated material for areas not within influence of paved areas or as indicated on the Drawings.

Maintain sufficient moisture content of fill materials to attain required compaction density. Maximum lift shall be 8 inches (20.3 cm) as it is placed before compaction. Compact backfill above bedding to 95 percent of maximum density under pavement, sidewalks, curbs, gravel roads, and the influence of pavement. Under green areas such as lawns, parks, and fields, compact backfill above bedding to 90 percent of maximum density, or as reflected on the drawings. Compaction means, methods and equipment shall be satisfactory and suitable for the applications, and shall be approved by the Engineer.

3.2.10 Protection. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.2.11 Cleaning. Dispose of all excess material used for trenching, backfilling, and compacting for the installation of electrical conduits and appurtenances at an approved offsite location, complying with all applicable codes and regulations.

3.3 FIELD QUALITY CONTROL. Compaction testing will be performed by an independent testing agency at the expense of the Contractor in accordance with the MDOT Standard Specifications, current edition.

3.3.01 Field Testing. If tests indicate work does not meet specified requirements, remove work, replace, compact, and retest.

End of Section

SECTION 02231

REMOVING/ABANDONING UTILITIES AND STRUCTURES

PART 1 - GENERAL

1.1 SCOPE. This work consists of removing, or abandoning, in whole or in part, sanitary and storm drainage structures, culverts, sanitary and storm sewers, fire hydrants, gate wells and water mains and other public or private utilities as required. Contractor shall coordinate with the appropriate public utility companies when removal of their appurtenances are required. Salvaging, storing, and disposing of removed materials, and the backfilling and compacting of the excavated sites is also included.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Concrete. Grade 30 P as per MDOT Standard Specifications for Construction.

2.1.02 Grout. A mixture of two parts sand to our part connector or similarly approved material.

2.1.03 Aggregate. 21AA as per MDOT Standard Specifications for Construction.

2.1.04 Caps. Mechanical Joint Caps conform to ANSI/AWWA/C110/A21.10 and be 350 psi (2413.16 kPa) pressure rated.

2.1.05 Restraint. The restraint shall be the series 1100 Megalug restraint as manufactured by EBBA Iron, Inc. or approved equal.

PART 3 - EXECUTION

3.1 SEWER/CULVERT REMOVAL AND ABANDONMENT. When removing or abandoning a sanitary or a storm drainage structure, any live sewers connected to them shall be rebuilt and properly reconnected through the removal area. Services shall be maintained during these construction operations using bypass pumping.

If the plans call for abandoning a sanitary or a storm drainage structure, the existing frames, covers and grates shall be carefully removed to prevent damage and the structure broken down to 3 feet (91.4 cm) below the pavement subgrade or at least 3 feet (91.4 cm) below the final ground elevation outside the pavement area.

Existing castings shall be considered as salvaged castings. Salvaged castings not suitable for use and not required for structures to be adjusted, shall become the Contractor's property and shall be promptly removed from the job site.

When special catch basin abandonment is called for in the Proposal and at locations shown on the Plans, the catch basin line shall be plugged at the lateral sewer as detailed on the Standard Plans. This special abandonment shall be used in site clearance and urban areas where the lateral sewer is remaining in service.

All pipe culverts specified to be removed, including all end treatments shall be completely removed.

Where existing culvert pipe is to be extended or the existing end treatment is to be replaced, only such portions of the existing culvert pipe shall be removed as to provide a proper connection to the new work. Care shall be taken to not damage any portion of the remaining culvert pipe.

All pipe culverts to be abandoned shall be bulkheaded as specified herein or by other approved methods. If the culvert is not in suitable condition for abandonment, in the judgment of the Engineer, alternate methods will be determined.

Culvert pipe designated to be abandoned, with top elevation within 6 feet (18.3 m) of the top of the pavement, shall be reviewed for removal.

3.1.01 Disposing of Materials. All excavated materials, together with all debris, stones, logs, stumps, roots, and other unsuitable materials, shall be removed from the site and disposed of by, and at the expense of, the Contractor.

3.1.02 Backfilling. Backfill the excavated areas with Aggregate 21AA. Backfilling shall be placed and compacted according to MDOT Controlled Density Method at least to 95 percent maximum weight.

All sewers (storm, sanitary, or combined) or parts thereof which are specified to be removed, or that interfere with the new construction, shall be removed.

Where existing sewers are to be extended or otherwise incorporated into the new work, only such part of the existing sewer shall be removed as to provide a proper connection to the new work. The connecting edges shall be cut, chipped, and trimmed to the required lines and grades without weakening or damaging the parts of the sewer to be retained.

3.1.03 Backfilling Abandoned Sewers. All sewers to be abandoned shall be bulkheaded with Grade 30 P concrete or with brick block masonry. A bulkhead shall be constructed from the inner wall of the drainage structure a minimum of 2 foot (61.0 cm) into the pipe or other method. If the sewer is not in suitable condition for abandonment, in the judgment of the Engineer, an alternate treatment will be determined.

An alternate procedure for backfilling abandoned sewers is to fill the sewer with grade 30M concrete or with grout composed of 2 parts sand to 1 part cement or variations thereof as may be approved by the contracting officer.

Backfill concrete shall be deposited through drop pipes placed over the abandoned sewer and at locations approved by the Engineer. Drop-pipe holes shall be spaced at intervals that will ensure the proper and complete filling of the sewer. All drop holes shall be sleeved for their entire length with a metal casing. The casing shall extend completely through the wall of the sewer. The drop-pipe shall be fitted with suitable and sufficient baffles to ensure the re-mixing of the concrete rather than a separation of the materials. The size of the drop-pipe shall be adequate for the placing of the concrete mix.

When the drop holes are no longer needed and the Engineer orders their abandonment, the castings shall be removed so that adjacent structures, utilities, and pavement will not be damaged. The hole shall then be filled with a 1500 psi concrete mix to within 5 feet (1.5 m) of the surface. The upper portion of the hole shall be filled with compacted sand or sand-gravel and the surface replaced in kind to that originally found to the satisfaction of the Engineer.

Grout shall be placed under a pressure adequate to fill completely the abandoned portion of the sewer. However, grout pressures shall not be so high as to cause leakage from the sewer and the filling of adjacent sewers, utilities and basements.

All sewers designated to be abandoned, with top elevation within 5 feet (1.5 m) of the pavement, shall be reviewed for removal.

3.2 Water Main and Appurtenances Removal. When removing or abandoning a water main, or appurtenances any live water connections to them shall be rebuilt and properly reconnected through the removal area. Services shall be maintained during these construction operations. Refer to the drawings for extent of removal and abandonment of water mains and appurtenances.

3.2.01 Disposing of Materials. All excavated materials, together with all debris, stones, logs, stumps, roots, and other unsuitable materials, shall be removed from the site and disposed of by, and at the expense of, the Contractor.

3.2.02 Backfilling. Backfill the excavated areas with Aggregate 21AA. Backfilling shall be placed and compacted according to MDOT controlled Density Method at least to 95 percent maximum weight.

Refer to the Drawings for details regarding removal and abandonment of other utilities and services.

End of Section

SECTION 02233

ADJUSTING AND RECONSTRUCTING STRUCTURES

PART 1 - GENERAL

1.1 SCOPE. This work consists of reconstructing all or portions of existing drainage and other structures and removing existing structure frames and covers and resetting them at the proposed elevations.

1.2 GENERAL.

1.2.01 Governing Standards.

Detroit City Engineering Division Standard Specifications for Paving and Related Construction, October 1999.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All work performed in the City of Detroit street and road right of ways shall comply with the City Engineering Division Standard Specifications for Paving and Related Construction.

2.2 MATERIALS. Concrete shall be Grade 30M as per 1990 MDOT Standard Specifications for Construction.

Aggregate shall be Series 21AA as per 1990 MDOT Standard Specifications for Construction.

Reinforcing Steel shall be Grade 60 steel bars as per 1990 MDOT Standard Specifications for Construction.

Concrete Masonry Unit bricks and blocks shall be as per 1990 MDOT Standard Specifications for Construction.

PART 3 - EXECUTION

3.1 INSTALLATION. Existing structures that are to remain shall have their tops adjusted to the new grades and cross-sections. Final adjustment of existing structures in bituminous surfaced areas shall be prior to placing the top course.

Adjusting covers shall only apply where the elevation of the cover is not changed more than 6 inches (15.2 cm) up or down. The contractor shall remove the frame and cover and reset the castings to the required elevation by supporting them on a metal ring adjustor, or a concrete collar, or on masonry in a full mortar bed. Adjusted covers shall be held firmly in place.

The adjacent pavement, curb, or curb and gutter shall be replaced to the required elevations.

3.1.02 Salvaged Castings. The metal frames, covers, and grates on existing structures that are to be reused shall be carefully removed to prevent damage.

Any reusable casting damaged by the Contractor shall be replaced with a new casting without additional cost to the City.

All salvaged castings that are not to be used on the work shall become the property of the Contractor and shall be promptly removed from the job site.

3.1.03 Structure Reconstruction. The existing frame and cover shall be carefully removed and the upper portion of the existing manhole structure raised or lowered as required. The frame and cover shall then be set on the adjusted structure to fit the required new grade and cross section.

Existing water gate and stop boxes, catch basin, and manhole frames or covers, or both, which require replacement or are non-standard castings, shall be furnished and installed by the Contractor. If the Engineer approves, replacement castings for standard units may be exchanged by the contractor for new castings at the DWSD Central Service Facilities – Materials Management, 6425 Huber, between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday. The Engineer shall furnish a written order authorizing the exchange of castings.

3.1.04 Water Gate Manhole and Stop Box Adjustment. The tops of existing water gate manholes and stop boxes shall be adjusted to the new required grades and cross-sections in the same manner as specified for drainage structures.

3.1.05 Manhole and Handhole Adjustment. The tops of existing P.L.D. manholes and handholes shall be adjusted to the new required grades and cross-sections as specified for sewer manholes.

If adjusting the frame and cover to the proposed grade requires adjustment of the manhole or handhole roof, the Contractor shall notify the P.L.D. The work involved in the adjustment of the roof of the structure and the adjustment of the frame and cover to the new surface will be performed by the Public Lighting Department at no cost to the Contractor.

Should existing castings require replacement, the Contractor shall furnish new castings. If the Engineer approves existing castings, the castings may be exchanged by the Contractor for new castings at the P.L.D. Warehouse, at 9449 Grinnell, between the hours of 8:30 a.m. and 4:00 p.m., Monday through Friday. The Engineer shall furnish a written order authorizing the exchange of castings.

End of Section

SECTION 02236

PIPE BORING AND JACKING

PART 1 - GENERAL

1.1 SCOPE. This section includes all labor, materials, tools and equipment required to complete pipe boring and jacking work. Boring and jacking consists of pushing a pipe through the earth. This method may also include pushing a pipe through the earth while a boring auger rotates within the pipe to remove the soil.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society of Testing Materials) A53 – Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

ASTM A139 Specification for Electric-Fusion (Arc)-Welded Steel Pipe (Sizes 4 inches and over).

ASTM C76 – Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

AWWA (American Water Works Association) C200 - Standard for Steel Water Pipe 6 inches and larger.

AWWA C203, Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.

AWWA C206, Standard for Field Welding of Steel Water Pipe.

AWPA (American Wood Preserver's Association) – Manual of Recommended Practice.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Contractor shall have minimum of 5 years documented experience in installations of similar size and character. Submit specific information and data demonstrating successful performance of similar jacking operations in similar situations and subsurface conditions.

1.3.02 Tolerances. Maximum deviation from established line and grade shall be 2 inches (5.1 cm) with a maximum allowable return of 2 inches (5.1 cm) per 100 feet (30.5 m). Maintain a minimum distance from the top of paved surfaces to the top of the installation.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Provide data for materials, equipment, and methods proposed for jacking and boring work. Submit shop drawings showing details of jacking pit, head, frame, reaction block, arrangement of jacks, receiving pit, sheeting for pits and trenches, location of pits, casing pipe and carrier pipe installation. Include plans and description of the boring arrangement at the head of the casing.

1.4.02 Certification. Furnish certificate of design and design calculations that show that all products and pipe boring and jacking details meet the requirements set forth on the Drawings and Specifications.

PART 2 – PRODUCTS

2.1 MATERIALS.

2.1.01 Casing Pipe. Steel pipe shall conform to AWWA C200, Grade B, with a minimum yield strength of 35,000 psi (241.3 MPa) with a nominal diameter and thickness as indicated. Longitudinal and girth seams shall be welded in accordance with ASTM A139. Pipe ends shall be beveled for field butt welded joints in accordance with AWWA C200. Length shall be as indicated.

2.1.02 Carrier Pipe. Steel pipe shall conform to ASTM A53, Type E or S, Grade B or ASTM A139, Grade B. Concrete pipe shall conform to ASTM C76, Class as indicated on the Drawings. Alternate carrier pipe must be approved by the Engineer.

2.1.03 Grout. Grout shall be a Portland cement, fly ash and water mixture. Bentonite will be added in some cases as specified. In certain conditions, a cement, sand and water mixture may be used with approval from the Engineer.

Water shall be of potable quality.

Cement shall be ASTM C150 Type I. Furnish cement used for grouting in 94 pound (42.7 kg) moisture resistant bags. Store cement bags in a waterproof temporary structure at the site of the work.

Bentonite shall be commercially processed, powdered montmorillonite clay meeting the requirements of the American Petroleum Institute Specification 13A.

Grout Fluidizers, accelerators or other admixtures shall not be used without a written request of the Engineer.

Fly Ash shall be ASTM C618 Type F. Furnish fly ash for grouting in 70 pounds (31.8 kg) moisture resistant bags. Store fly ash bags in a waterproof temporary structure at the site of the work.

Grout shall be a 3:1 mix by volume of water to cementitious material or 22.5 gallons (85.2 L) of water per 96 pounds (43.6 kg) of cement/fly ash. The cement/fly ash ratio may vary from 1:1 to 1:3 depending on the stiffness required. Bentonite shall not be added without a written request of the Engineer. The Contractor may revise the grout mix in the field according to specified site conditions with approval from the Engineer.

2.1.04 BLOCKING AND WEDGING. Wood blocking shall be pressure treated with creosote to a retention of at least 10 pounds (4.6 kg) per cubic foot (0.028 cu m) in accordance with American Wood Preserver's Association, "Manual of Recommended Practice." Creosote oil shall be Class 1 oil in accordance with Federal Specification TT-C650 C for creosote, coal tar solution. Fillet leading and trailing edges of blocks to ease sliding.

PART 3 – EXECUTION

3.1 PREPARATION. Prior to start of work, assemble all materials, equipment and tools necessary to conduct jacking and boring work continuously until completed.

Blasting is not permitted within limits of jacking and boring. Rocks shall be removed by hand held equipment.

3.2 INSTALLATION.

3.2.01 Boring and Jacking of Casing Pipe. Proposed methods shall be evaluated on a case-by-case basis by the Engineer prior to construction. Water or air jetting; and air rams, missiles or hole hogs are not recommended methods. Generally, boring and jacking consists of pushing the pipe into the fill with a boring auger rotating within the pipe to remove the soil. When augers, or similar devices, are used for pipe emplacement, the front of the pipe shall be provided with mechanical arrangements or devices that will positively prevent the auger and cutting head from leading the pipe so that here will be no unsupported excavation ahead of the pipe.

The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered. The over-cut by the cutting head shall not exceed the outside diameter of the pipe by more than one-half inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow of soft or poor material.

The approach trench shall be large enough to accommodate at least one section of pipe, jacks, and blocking. Two rails or sills shall be laid in the bottom of the trench to keep the pipe at the established line and grade. When jacking pipe under railroad tracks, sheeting and bracing plans of jacking pits shall be submitted for approval of the railroad company through the Engineer. Excavation of the jacking pipe shall not be started until such approval has been received.

The use of water or other liquids to facilitate casing emplacement and spoil removal is prohibited.

Any method which employs simultaneous boring and jacking which does not utilize the method described above WILL NOT BE PERMITTED.

Bored or jacked installations shall have a bored hole essentially the same as the outside diameter of the pipe. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe by more than approximately 1 inch (2.5 cm), grouting or other methods approved by the Engineer shall be employed to fill such voids.

Grouting shall be completed immediately upon completing the bore. Bracing shall be immediately strengthened at the first notice of any earth movement. If the access pit becomes unsafe, the access pit shall be stabilized immediately and all voids filled as approved by the Engineer.

Pressure grouting of the soils or freezing of the soils before jacking and boring as required at the direction of the Engineer to stabilize the soils, control water, prevent loss of material and prevent settlement or displacement of embankment. Grout shall be cement, chemical or other special injection material selected to accomplish the necessary stabilization.

The materials to be used and the method of injection shall be prepared by a Professional Engineer registered in the State of Michigan, or by an experienced and qualified company specializing in this work and submitted for approval to the Engineer before the start of work. Proof of experience and competency shall accompany the submission.

When water is known or expected to be encountered, pumps of sufficient capacity to handle the flow shall be maintained at the site and, upon approval of the Engineer they shall be in constantly attended operation on a 24 hour basis until, in the sole judgment of the Engineer their operation can be safely halted. When dewatering, close observation shall be maintained to detect any settlement of adjacent roadways, embankments and adjacent facilities.

If during installation an obstruction is encountered which prevents installation of the pipe in accordance with this specification, the pipe shall be abandoned in place and immediately filled with flowable fill. A new installation procedure and revised plans must be submitted for approval before work can resume.

3.2.02 Sheeting and Bracing. Provide sheeting and bracing when any excavation is located within the influence area of a paved area. Support shall be required at the front face of all access pits in bore and jack operations to prevent loss of material during construction.

3.2.03 Casting Pipe. Full-circle butt welded joints shall be in accordance with AWWA C206. Field welded joints shall be coated and lined with coal tar enamel in accordance with AWWA C203. Invert of casing pipe shall be lubricated to ease carrier pipe insertion.

3.2.04 Casing Pipe End Seals. Casings for carrier pipes of flammable and hazardous substances shall be suitably sealed to the outside of the carrier pipe. Details of the end seals shall be shown on the plans.

Casings for carrier pipes on non-flammable substances shall have both ends of the casing blocked up in such a way as to prevent the entrance of foreign material.

3.2.05 Carrier Pipe. Install true to line and grade as indicated and as specified. Exercise care to prevent damage to casing pipe and carrier pipe.

The Contractor shall use temporary spacers when installing the carrier pipe to maintain interior joint annular spacing as recommend by the pipe manufacturer.

3.2.06 Grout. The Contractor shall fill the annular space between the carrier pipe and casing with Portland cement grout as specified herein.

The grout shall be injected under pressure in one operation. Wood blocking or other means of support for the carrier pipe shall be provided to prevent floating.

3.2.07 Backfilling and Restoration. Access pits and excavations shall be backfilled with approved suitable material.

The disturbed surface area shall be top-soiled, seeded, fertilized, mulched, and anchored. Refer to the section on Landscaping if applicable. If final restoration is not completed within 5 days after completion of the bore and jack operation, temporary erosion control measures shall be required as directed by the Engineer.

Upon completion of work, the Contractor shall remove and properly dispose of all excess materials and equipment.

End of Section

SECTION 02316

ROCK REMOVAL

PART 1 - GENERAL

1.1 SCOPE. This section includes removal of rock encountered during excavation, including explosives, tools, and equipment necessary to assist in rock removal.

1.2 GENERAL.

1.2.01 Governing Standards. NFPA 495 (National Fire Protection Association) - Code for Manufacture, Transportation, Storage, and Use of Explosive Materials. MIOSHA Part 27 – Blasting and Use of Explosives.

1.2.02 Definitions. Rock is defined as a solid material which does not soften when wet and which cannot be excavated without continuous drilling, sawing, blasting, or continuous use of a ripper or other special equipment. Boulders of 1/2 cubic yard (0.4 cu m) or more in volume are also included as rock.

1.2.03 Permits. Before using explosives Contractor shall secure all required permits from the authorities having jurisdiction.

1.3 QUALITY ASSURANCE.

1.3.01 Contractors Qualifications. Seismic survey firm shall be a licensed company specializing in seismic surveys with 5 years documented experience.

Explosives firm shall be a company specializing in explosives for disintegration of rock, with 5 years documented experience.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate the proposed method of removal including blasting, delay pattern, explosive types, type of blasting mat or cover, and intended rock removal method.

1.4.02 Survey Report. Submit survey report on conditions of buildings near locations of rock removal.

1.5 DELIVERY, STORAGE, AND HANDLING. The Contractor shall store and handle all explosives and accessories as accordance with federal, state, and local laws, regulations, and ordinances and manufactures instructions.

All explosives shall be stored in approved structures and detonators shall be stored separation.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Conduct survey with the Engineer and document conditions of buildings near locations of rock removal prior to blasting and photograph existing conditions identifying existing irregularities.

Advise owners of adjacent buildings or structures in writing prior to executing seismographic survey. Explain planned blasting and seismic operations.

Obtain a seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

2.2 MATERIALS.

2.2.01 Explosives. Type recommended by explosive firm following seismic survey and required by authorities having jurisdiction.

2.2.02 Delay Device. Type recommended by explosives firm.

2.2.03 Blast Mat Materials. Type recommended by explosives firm.

PART 3 - EXECUTION

3.1 EXAMINATION. Verify site conditions and note subsurface irregularities affecting work of this section.

3.2 PREPARATION. Identify required lines, levels, contours, and datum.

3.3 REMOVAL.

3.3.01 Mechanical Method. Excavate and remove rock by mechanical method. Drill holes and use expansive tools, wedges or mechanical disintegration compound to fracture rock. Cut away rock at bottom of excavation to form level bearing. Remove shaled layers to provide sound and unshattered base for foundations. In utility trenches, excavate to 6 inches below invert. Remove excavated materials from site. Correct unauthorized rock removal as directed by Engineer.

3.3.02 Rock Removal by Explosive Methods. If rock is uncovered requiring the explosives method for rock disintegration, notify the Engineer. The Contractor shall not use any explosives without the Engineer’s approval. Provide seismographic monitoring during progress of blasting operations. Remove rock as recommended by the explosive firm. Remove excavated material from site. Correct unauthorized rock removal as directed by the Engineer.

3.4 FIELD QUALITY CONTROL. Provide for visual inspection of foundation bearing surfaces and cavities formed by removed rock.

End of Section

SECTION 02321

FLOWABLE FILL

PART 1 - GENERAL

1.1 SCOPE. This section includes the furnishing and installation of flowable fill in areas indicated on the drawings and as specified and approved by the Engineer.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C150 (American Society for Testing and Materials) – Portland Cement.

ASTM C260 – Air – Entraining Admixtures for Concrete.

ASTM C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Concrete.

ASTM C989 – Ground Grannulated Blast – Furnace Slag for in Concrete and Mortars.

MDOT (Michigan Department of Transportation) Current Standard Specification for Construction.

1.3 SUBMITTALS. Submit a test report of specified flowable fill material properties.

1.3.01 Test Reports. Submit a flowable fill mix design and trial batch report to the Engineer minimum of 7 days prior to placement. The mix design shall show source and type or class of materials and batch proportions.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The compressive strength of the flowable fill mixture will not be less than 50 psi (344.7 kPa) at 3 days, nor less than 75 psi (517.11 kPa) and will not exceed 150 psi (1,034.22 kPa) at 28 days.

If an air entraining admixture or performance enhancing admixture is used, then the air content of the flowable fill will not exceed 35 percent of the Flowable Fill volume.

2.2 MATERIALS.

2.2.01 Flowable Fill. Flowable fill shall consist of variable quantities of Type I Portland Cement, granular material or fine aggregate, fly ash and water mixed together and utilized as a controlled density fill. Optional materials, including ground grannulated blast furnace slag, air-entraining admixture and performance enhancing admixture, if required will be indicated on the Drawings or specified by the Engineer.

2.2.02 Granular Material. Granular material shall meet current MDOT Standard Specifications for Construction for Class II requirements except that 100% percent shall pass the 1/2 inch (13 mm) sieve. Fine aggregate shall conform to the requirements of MDOT Type ANS material.

2.2.03 Fly Ash. Fly ash shall meet requirements of ASTM C618 Class F with no limit on the loss of ignition.

2.2.04 Ground Grannulated Blast Furnace Slag. Ground blast furnace slag shall conform to ASTM C989, Grade 100. It shall be used only as a blending material with Type I or Type IA Portland Cement.

2.2.05 Air-Entraining Admixture. Air-entraining admixture used for flowable fill shall conform to ASTM C260.

2.2.06 Performance Enhancing Admixtures. Performance enhancing admixtures are stable high air generators that produce a low water content flowable fill. Performance enhancing admixtures are used to improve flowability, lower densities, eliminate segregation and settlement, and control strength development. If used, the performance enhancing admixture must be included in the mix design and trial batch, and must be used according to the Manufacturer's recommendation.

2.2.07. Mixture. The flowable fill mix proportions shall consist of the following or an approved alternate mix may be provided.

Material	Pounds/Cubic Yard (kg/cu m)
Portland Cement (Type I)	50 (22.68)
Granular Material	3400 (1542.24)
Fly Ash (Class F)	200 (90.72)
Water	Sufficient water to provide the desired flowability (approx. 40 gal (151.42 l))

The mix proportions may be adjusted by the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION. Prior to placement of flowable fill, inspect areas around structures, trenches, and other excavated areas to be filled and ensure that large foreign objects have been removed. The temperature of the flowable fill mix, as it is manufactured and delivered, shall be at least 50º F (10 degrees C). The flowable fill mix shall be transported to the point of placement in a revolving drum mixer or agitator.

3.2 INSTALLATION. Place flowable fill in a manner similar to that for concrete but that adheres to the general requirements for backfilling, according to Section 2.09 of the current MDOT Standard Specifications for Construction, or as approved by the Engineer.

Twenty-four hours will elapse from start to start of each subsequent placement. No placement of flowable fill will be allowed if the anticipated air temperature will be 35° F (17° C) or less in the 24 hour period following proposed placement.

The batching equipment will have devices designed to measure the specified quantities of each component material, and mixing will be of sufficient duration to insure uniform consistency of the mixture. No water will be added to the flowable fill mixture after batching. Water content will be maintained such that compressive strengths are achieved leveling when placed.

During placement operations around manholes and in utility trenches, care shall be used to avoid dislocating any pipes due to fluid pressure from the flowable fill by even placing of the material. Any pipes within the backfill area should be considered for securing to avoid buoyant effect of flowable fill.

When flowable fill is used in pavement cuts, the fill shall be placed to the top of pavement. After setting, the flowable fill is to be removed to the bottom of a concrete pavement patch or to the top of the bituminous base course.

End of Section

SECTION 02342

SOIL STABILIZATION

PART 1 - GENERAL

1.1 SCOPE. This section includes all work necessary to treat existing site subsoil for physical stability and slope protection specified herein and as indicated on the drawings.

Soil stabilization consists of excavating, treatment, and placement of soil cement or lime treated subsoil mix and also placing riprap and rock lining.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C150 – Portland Cement.

ASTM C977 – Quicklime and Hydrated Lime for Soil Stabilization.

ASTM D698 – Test Method for Moisture Density Relations of Soils and Soil-Aggregate Mixtures, using 5.5 lb. (2.5 kg) Rammer and 12 inch (30.5 cm) drop.

ASTM D1633 – Test Method for Compressive Strength of Molded Soil – Cement Cylinders.

AASHTO M216 (American Association of State Highway and Transportation Officials) – Lime for Soil Stabilization.

NLA (National Lime Association) Bulletin 326 – Lime Stabilization Construction Manual.

1.3 QUALITY ASSURANCE. Perform lime stabilization work in accordance with NLA Bulletin 326. Alternatively perform soil stabilization work in accordance with Michigan Department of Transportation (MDOT) Standard Plans and Specifications or as indicated on the drawings.

1.3.01 TOLERANCES. Top surfaces of fill shall be plus or minus 1 inch (2.5 cm) from required elevations.

1.4 SUBMITTALS.

1.4.01 Product Data. Submit mix design and materials mix ratio that will achieve specified requirements.

1.4.02 Samples. Submit sample of each type of fill in air-tight containers to testing laboratory.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Riprap. Provide riprap and heavy riprap in accordance with MDOT Standard Specifications for construction as indicated on the drawings.

2.1.02 Soil Mix Materials. Reuse existing subsoil material combined with ASTM C150 Normal Type I Portland Cement, unless indicated otherwise.

2.1.03 Soil Cement or Lime/Soil Mix. Mix materials in accordance with MDOT Standard Plans and Specifications or as indicated on the drawings. Add water to the mix to achieve a homogeneous damp mixture without lumping, yet not creating a wet plastic consistency. Mix materials in accordance with MDOT Standard Plans and Specifications or as indicated in the drawings.

2.1.04 Curing Seal. Shall be asphalt emulsion primer.

2.1.05 Geotextile Fabric. Shall be non woven polypropylene manufactured by TC Mirafi, Tensar Earth Technologies, Inc., or an approved equal.

2.1.06 Membrane Curing Compound. Compound shall conform to requirements of ASTM C309, Type I, Class B Vehicle with no discoloration properties.

2.1.07 Equipment. Capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting materials.

PART 3 - EXECUTION

3.1 INSPECTION. Do not place materials over frozen or spongy subgrade surfaces.

3.2 PREPARATION. Coordinate requirements with piling operations, if applicable.

3.3 PERFORMANCE.

3.3.01 Excavation. Protect adjacent structures from damage by this work. Excavate subsoil to a depth sufficient to accommodate soil stabilization, and construction operations. Proof roll subgrade to identify soft areas; excavate those areas. Do not excavate within normal 45 degree bearing splay of any foundation.

Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard (0.25 cu m) measured by volume. Larger material will be removed under Master Specification Section 02211 or as directed by the Engineer. Notify Engineer of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.

Stockpile excavated material in area designated on site; remove excess material not being reused from site.

3.3.02 Soil Treatment and Backfilling. Place geotextile fabric over subsoil surface, lap edges and ends.

Site mix subsoil, backfill and compact. Blend treated subsoil mix to achieve mix formulation and required stabilization.

For lime treated stabilization mixes, mix and wait 16 hours minimum and no more than 72 hours maximum before placing. Place mix material in continuous layers not exceeding 12 inches (30.5 cm) depth.

Maintain optimum moisture content of mix materials to attain required stabilization. If more than one layer, maintain lower layer at optimum moisture until next layer is placed.

For soil cement mixes, place mixed materials within 2.5 hours of adding water to mix. Do not exceed 30 minutes in placing adjacent mixed material. Commence compaction of mix no later than 60 minutes after placement. Compact mix to ASTM D1633 for soil cement mixes and to ASTM 0698 for lime treated mixes.

Slope grade away from building minimum 2 inches (5.1 cm) in 10 feet (3.1 m) unless noted otherwise. Shape to required line, grade, and cross section. Make grade changes gradual. Blend slopes into level areas. At end of day, terminate completed work by forming a straight and vertical construction joint.

Replace damaged fill with new mix to full depth of original mix. Remove surplus mix materials from site.

3.3.03 Curing. Immediately following compaction of mix, seal top surface with curing seal or as indicated on drawings. Do not permit traffic for 72 hours after sealing top surface.

3.3.04 Riprap Replacement. Place geotextile fabric over substrate, lap edges and ends a minimum of 2 feet (61.0 cm) with the upgrade section overlapping the downgrade section. Place riprap at culvert pipe ends, at embankment slopes, and wherever indicated on the drawings.

Plain Riprap: The bank of which plain riprap is to be placed shall be trimmed to a uniform slope as shown on the plans. The riprap shall commence in a trench below the toe of the slope, as shown on the plans, and shall progress upward, with each stone firmly bedded into the slope and against the adjoining stones. The stones shall be laid perpendicular to the slope with the surfaces in contact and with well broken joints. The riprap shall be thoroughly compacted as the construction progresses, and the finished surface of the riprap shall present an even, tight surface. The thickness of the riprap other than precast concrete blocks, shall not be less than 8 inches (20.3 cm), measured perpendicular to the slope. Individual stones shall be laid with their 8-inch (20.3 cm) minimum dimension perpendicular to the plane of the surface to be riprapped.

Grouted Riprap: The stones shall be laid as specified for plain riprap. The spaces between the stones shall be filled with MDOT type R-3 or equal. Mortar shall be placed from bottom to top and sufficient mortar shall be used and worked with suitable tools to completely fill all voids, except that the face surface of the stone shall be left exposed. Any excess mortar shall be removed with a stiff brush.

Grouted riprap shall be cured and protected for a minimum of 4 days by being kept continuously wet or by the application of transparent membrane curing compound.

Heavy Riprap: The bank of which the heavy riprap is to be placed shall be trimmed to a uniform slope as shown on the plans. Heavy riprap shall be constructed in accordance with the requirements for plain riprap except that the thickness of the riprap, other than precast concrete blocks, shall be not less than 16 inches (40.6 cm) measured perpendicular to the slope. Individual stones shall be laid with their 16 inch (40.6 cm) minimum dimension perpendicular to the plane of the surface to be riprapped. When broken pavement is used, it shall be laid in 2 layers with staggered joints and all voids filled to the satisfaction of the Engineer.

3.4 FIELD QUALITY CONTROL. Testing will be performed by an independent testing laboratory paid for by the Contractor. Compression test and analysis of hardened fill material will be performed in accordance with ASTM D1633.

If tests indicate that work does not meet specified requirements, remove work, replace and retest at no cost to Owner.

End of Section

SECTION 02461

STEEL SHEET PILING

PART 1 - GENERAL

1.1 SCOPE. Furnish all labor, materials and equipment to install steel sheet piling where required and where shown on the drawings.

Extent of the steel sheet piling includes, but is not limited to, the following:

Steel sheet piling necessary to protect existing structures, earth, roads, walkways, utilities, and other improvements against loss of ground or caving embankments without producing damage to the adjacent building structures, roads, and/or utilities.

Maintenance of the steel sheet piling and support systems.

Removal and/or relocation of bracing as required.

The configurations of the steel sheet piling may include but are not limited to the following:

Steel sheet piling with walers and struts

Tied-back steel sheet piling

Cantilevered steel sheet piling

A portion of the sheeting may be required to hold back Soil and Water from entering the excavation. As such, the contractor shall be prepared to address all leaking and water inflow through the sheeting interlocks. In any case, the steel sheeting must conform to the minimum requirements indicated on the contract drawings.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM A36: Specification for Structural Steel

ASTM A328: Specification for Steel Sheet Piling

ASTM A572: Specification for High Strength Steel Sheet Piling

ASTM A307: Specification for Steel Bolts and Nuts

AWS: Structural Welding Code

1.3 SUBMITTALS. In accordance with the procedures and requirements set forth in the General Conditions and Division 1, the Contractor shall submit the following:

Two (2) copies of mill test reports certifying that materials meet ASTM requirements.

Photographs of existing structures adjacent to work area.

Survey of existing structures adjacent to work area.

Sample driving record forms.

Schedule of Procedures and Operations.

Details of pile driving equipment.

Shop Drawings.

Each submittal shall be identified by the Specification Section Number.

Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed materials compliance with the Documents.

Schedule of Procedures and Operations:

Before commencing any steel sheet pile installation, the Contractor shall submit to the Engineer for approval, a schedule of the procedures he intends to use. The schedule shall show in detail, his proposed method, sequence and timing of all steel sheet piling driving operations, catalog data and manufacturer's specification for all hammers and anvils to be used, method of lifting, handling, driving and cutting off of steel sheet piles. The submission of Contractor's details and other information to the Engineer shall not relieve the Contractor of any part of his responsibility for the successful completion of the work.

Shop Drawings shall include but not be limited to:

Layout drawings indicating all structural shapes, sizes and dimensions.

Details of all bracing.

PART 2 - PRODUCTS

2.1 MATERIALS. Steel Sheet Piling shall be hot rolled and shall conform to the requirements of ASTM A328. Sheet piles shall be new and shall be of the continuous interlock type of the section, length and weight shown on the Drawings.

Walers, braces, structures, tie-rod assemblies, plates and similar members shall conform to the requirements of ASTM A36.

Bolts, nuts and washers shall conform to the requirements of ASTM A307.

2.2 FABRICATION. Steel sheet piling shall be so fabricated that when driven in place, it will form a continuously interlocked wall for each structure to the extent required. Steel sheet piling shall be fabricated in one continuous length.

Walers and braces may be prefabricated or fabricated in place. All welding shall conform to the requirements of AWS D1.1-80.

PART 3 - EXECUTION

3.1 INSTALLATION. Steel sheet piling shall be carefully located and driven in a plumb position, to the required tip elevations, each sheet pile interlocking with the adjacent sheet pile so as to form a single continuous wall. Sheet piles shall be driven by approved methods in such a manner as not to subject the sheet piles to serious injury and to insure continuous interlocking throughout the length of the sheet piles. Pile hammers shall be maintained in proper alignment during driving operations. A suitable guide system shall be used to permit the sheet piling to be driven plumb and on-line. Any obstructions encountered in driving the steel sheet piling shall be removed or otherwise disposed of so as to permit the proper installation of the sheet piling. Any sheet piling, which at any time becomes damaged, displaced, separated from adjacent sheets or otherwise injured, shall be withdrawn and replaced with new sheet piling at the expense of the Contractor.

Equipment: The Contractor shall provide and maintain in good operating condition, all equipment necessary for the proper and efficient handling and installation of the sheet piles. The Contractor shall have all major equipment items available for inspection by the Engineer. Any deficiencies in quality, quantity or type of equipment shall be corrected prior to commencing work and such correction shall be a required condition to properly fulfill the Contract. This inspection and subsequent approval shall in no way relieve the Contractor from his obligation to provide all equipment required to properly perform the work.

Hammers: Pile hammers shall be steam, diesel, or air driven impact hammers or vibratory type hammers. Hammers shall be maintained in good operating condition and shall be operated at the manufacturer's rated number of blows per minute. The lower end of the hammer shall be fitted with an anvil base that is built to fit the top of the steel sheet piling and to hold the sheet piling under the center of the hammer during driving.

Driving Records: Steel sheet piling shall be driven only in the presence of the Engineer. The Contractor shall provide a qualified individual to compile and turn over to the Engineer a daily record of driving data. The complete record of each day's activity shall include the number of sheet installed, the length of each, equipment and personnel utilized, and general remarks regarding the day's activity.

Accuracy of Driving: Piles shall be driven to a tolerance of not more than 1/8 inch per foot for the vertical.

Leave sheeting in place where shown on the drawings or as directed by the Engineer. Cut off sheeting left in place a minimum of three feet below finished grades.

3.2 MONITORING. Before starting work, the Contractor shall check and verify governing dimensions and elevations. In company with the Engineer, he shall jointly survey the condition of adjoining structures. He shall take photographs, as directed by the Engineer, recording any prior settlement of cracking of structures, pavements, and other improvements. He shall prepare a list of such damages, verified by dated photographs, and signed by the Contractor and the Engineer participating in the investigation.

The Contractor shall survey adjacent structures and improvements, establishing exact elevations at fixed points to act as bench marks. He shall clearly identify bench marks and record existing elevations. Datum level used to establish bench mark elevations shall be located at a sufficient distance so as not to be affected by movement resulting from excavation or construction operations.

During excavation, the Contractor shall resurvey bench marks weekly, employing a licensed Land Surveyor or registered Professional Engineer. He shall maintain an accurate log of surveyed elevations for comparison with original elevations. He shall promptly notify the Engineer if changes occur or if cracks, sags or other damage is evident.

Vibrations from pile driving operations shall be limited to a measured 1 inch per second peak particle velocity at any adjacent structure. If recorded vibrations exceed the above limit, the contractor shall modify driving operations to reduce vibrations to below the above limit.

3.3 TESTING. All inspection and testing of welds shall be performed in accordance with the provisions of AWS D1.1-810. Welders shall be qualified in accordance with the requirements of AWS D1.1-80.

End of Section

SECTION 02462

STEEL H PILES

PART 1 - GENERAL

1.1 SCOPE. Section includes rolled steel H-section piles. Also covered are pile driving and pile load tests. Structural steel is covered separately.

1.2 GENERAL.

1.2.01 Coordination. Convene a pre-installation meeting a minimum of one week prior to commencing pile-related work.

Follow the Geotechnical Investigation Report recommendations for pile driving.

1.2.02 Governing Standards.

ASTM A6 – General Requirements for Rolled Steel Bars, Plates, Shapes, and Sheet Piling.

ASTM A36 - Carbon Structural Steel.

ASTM A572 Grade 50 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

AWS D1.1 (American Welding Society) – Structural Welding Code - Steel.

AWS D1.5 (American Welding Society) - Bridge Welding Code.

SSPC SP-5 (Steel Structures Painting Council) – White Metal Blast Cleaning.

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Welders employed on the job, must have certification verifying AWS qualification within the previous 12 months.

1.3.02 Contractor’s Qualifications. Company specializing in performing work of this section with minimum 5 years documented experience.

1.3.03 Tolerances.

Maximum Variation From Vertical For Plumb Piles: 1 in 48.

Maximum Variation From Required Angle For Batter Piles: 1 in 24.

Maximum Variation From Pile Cut-off Elevation: 4 inches (10.2 cm).

Maximum Out-of-Position: 2 inches (5.1 cm).

After splicing, the alignment of the centerline of the undriven portion of the pile shall not deviate from the alignment of the centerline of the driven portion of the pile by more than 3/8 inch (1.0 cm) in 40 feet (12.2 m).

After installation, the horizontal deviation of the centerline of the pile at the pile top from the alignment of the centerline of the pile shown on the Drawings shall not be greater or less than an amount equal to two percent of the length over which the alignment is being measured.

Piles at cut-off elevation shall not deviate laterally from required location by more than the tolerance shown on the Drawings. Piles shall not be pulled into location by more than amount shown on Drawings.

1.3.04 Testing Qualifications. Monitor test pile placement under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of Michigan.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate details and schedule of pile installation sequence. Identify recommended pile length and shapes to suit design loads.

Complete information and data pertaining to the pile driving equipment, including certification of the hammer and details of the capblock and driving head, shall be submitted to the Engineer for review before any driving is done.

Submit details of collars, tips, splices, cushion blocks and welding details.

1.4.02 Certifications. Provide manufacturer's mill certificate that certifies that steel piles meet or exceed specified requirements.

1.4.03 Test Reports. Wave Analysis test results shall be submitted to the Engineer in all required stages, including hammer selection, indicator pile testing program and production piling as required.

1.4.04 Record Drawings. Accurately record the sizes, lengths, and locations of piles, date of driving, pile hammer used, sequence of driving; number of blows per foot (20.5 cm) for entire length of piles and provide a measured set for last 10 blows;

identify piles requiring drilling and their hole diameters, final base and top elevations, and the driving force of each hammer blow.

In addition to the above, pile driving records indicating data recorded as specified herein shall be submitted no later than 2 days after the pile has been completed including final cut-off operations, survey and documentation.

Select pile components not otherwise specified under direct supervision of a professional engineer experienced in design of this work and licensed at the place where the project is located.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Do not drive piles until excavation or filling in the area they are to occupy has been completed to the design grades shown on the Drawings. Do not drive piles until mud-line is clear of debris or other material that may interfere with pile driving. Do not drive piles until the Engineer has approved sequence of driving for all piles. Protect existing structures, including overhead and buried utility lines.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Drive piles to refusal in or on the underlying hard pan. Piles properly driven to refusal in or on the underlying hard pan can develop a compressive capacity equivalent to the maximum allowable stress in the pile.

2.3 MATERIALS. Piles shall comply with ASTM A6, ASTM A36; for structural steel, rolled H sections, with a minimum 36 ksi (248.2 MPa) yield strength; sizes and lengths as indicated on plans. Comply with ASTM A572 Grade 50, for high strength steel rolled H-sections, sizes and lengths as indicated on plans. Use points and driving caps to suit pile shape.

The Contractor shall provide all driving and inspection equipment necessary to determine whether the pile has been started in its planned location, is vertical or at the prescribed batter, and is within allowable tolerance for position after driving.

PART 3 - EXECUTION

3.1 PREPARATION. Obtain prior approval of hammer type to be used. Use driving method, which will not cause damage to nearby structures. Notify adjacent and affected land owners and building occupants with notice before proceeding with the work. Protect structures near the work from damage. Prepare to place piles from excavated working elevation.

3.2 INSTALLATION. Use rigid frame, fixed lead type driving equipment capable of supporting pile firmly in vertical position or to required batter.

Protect pile head during driving, using an approved cap-block cushion consisting of alternate plates of phenolic laminate and aluminum designed to prevent damage to the piles while also transmitting the right amount of energy to the pile top as required, with full bearing on pile butt for even distribution of hammer blow.

Deliver hammer blows to central axis of pile.

If driving is interrupted before refusal, drive an additional 12 inches (30.5 cm) before resuming recording of performance data.

Re-drive piles which have lifted due to driving adjacent piles, or by soil uplift.

Do not damage piles during driving operations.

Cut off tops of piles to elevations indicated and prepare pile top to receive pile caps.

3.2.01 Pile Driving. Driving operations shall be performed only in the presence of the Engineer. The piles must be driven to refusal in competent bedrock. Refusal is defined as 5 hammer blows required to advance the pile ¼ inches or less. The pile driving hammer must have a minimum rated energy of 13,000 foot-pounds per blow. It is recommended that the pile tip be reinforced using an Associated Pile & Fitting Corporation Hard Bite HP77600 Point or equivalent to prevent twisting, buckling, or tearing of the web from the flange.

Top of pile shall be normal to the driving force. Maintain accurate alignment of the pile, hammer and leads to minimize bowing of pile during impact of the hammer ram.

Where groups of piles are required, drive the center pile of the group first and then drive the remaining piles in the group progressing outward from the center.

Drive piles to the minimum tip penetration(s) and to the required driving resistance. Take corrective action, if required, to prevent observable impact bowing of pile at final driving resistance.

When resistance to driving makes it impossible to advance the pile to the required minimum tip penetration, spud, jet, jet and drive, or use such other means as necessary to permit advancement to required minimum tip penetration and then drive to the required resistance. Jetting will be permitted when within the limits specified. If jetting is performed, immediately adjacent piles shall be redriven to the driving resistance required.

Pre-drilling or pre-augering a hole of maximum diameter 2 inches (5.1 cm) smaller than the pile flange dimension may be used to advance the pile to a penetration no deeper than the required minimum tip penetration, providing the pile is driven to the required driving resistance. In granular soils below the ground water level, stabilize the hole by use of drilling fluids.

3.2.02 Pile Hammer. Use a pile hammer complying with the requirements shown on the Drawings. Hammers shall be subject to prior approval by the Engineer. Keep hammer in good mechanical condition and operate it at the speed and pressure recommended by the manufacturer.

During pile driving operations, the Engineer may make occasional measurements of the velocity of the hammer ram using a Hammer Performance Analyzer (radar gun device), as manufactured by Pile Dynamics, Inc., Cleveland, Ohio, or approved equal, to be furnished by the Owner. If the energy per blow computed on the basis of the measured ram velocity at impact is less than 80 percent of the rated energy per blow as specified by the manufacturer of the pile hammer, the Contractor shall make all necessary repairs so as to improve the energy output to a value of at least 80 percent of the rated energy per blow, or, alternatively, the Contractor shall replace the pile hammer.

3.2.03 Welding and Splicing. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.1 for buildings or AWS D1.5 for bridges and other structures. Only use welders qualified by tests prescribed in AWS D1.1 or AWS D1.5, as applicable.

Reinforce pile tips, if and when necessary.

Unless stricter requirements are shown on the drawings, splice sections of pile with complete penetration butt weld of flanges and web, provided however, during actual pile installation only, use of the Splicer Sleeve No. BP-3000 as manufactured by Associated Pile and Fitting Corporation, Clifton, New Jersey, with flanges welded with full penetration groove welds, is permitted. Use an approved jig or alignment device during welding to maintain the required straightness of pile specified elsewhere in this section. For splices made during pile installation, rigid frame pile leads may be used as a jig. Notwithstanding the above, only approved butt weld splices shall be permitted within 20 feet (6.1 m) from pile cut-off elevation or design grade, whichever is lower.

The number, type and location of splices shall comply with the following limitations:

No more than three splices per pile over 100 feet (30.5 m) long.

No more than two splices per pile up to 100 feet (30.5 m) long.

No splice closer than 25 feet (7.6 m) from the tip.

3.4 FIELD QUALITY CONTROL. Unacceptable piles include piles that fail tests, piles that are placed out of position, piles that are below cut-off elevations, or piles that are damaged. Provide additional piles or replace piles to conform to specified requirements. The bearing value shall be determined by pile penetration method in accordance with Section 5.02 of the MDOT 1990 Standard Specifications for Construction.

End of Section

SECTION 02530

SANITARY SEWERS

PART 1 - GENERAL

1.1 SCOPE. Section includes sanitary sewerage drainage piping, fittings, manholes, manhole covers and frames, accessories and bedding, sewer leads, cleanout and connection of building sanitary drainage system to municipal sewers.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM A53 – Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.

ANSI/ASTM C76 - Concrete Culvert, Storm Drain, and Sewer Pipe.

ANSI/ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

ASTM D2680 - Acrylonitrile - Butadiene - Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite.

ASTM D3262 - “Fiberglass” (Glass-Fiber-Reinforced Thermosettting-Resin) Sewer Pipe.

ASTM F1803 - Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.

ASTM F949 - Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings.

MDOT Standard Specifications for Construction, Current Edition.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. All sewer pipe provided for this project shall be manufactured by a pipe manufacturer with a minimum of 5 years history producing the product. Verification of such experience is required with the submittal of the Proposal.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit product data indicating pipe, pipe accessories, and manholes.

Submit manufacturer's installation instructions and indicate special procedures required to install Products specified. Submit sheeting and bracing plans for the jacking pits. Submit construction procedures and necessary details for jacking.

1.4.02 Certifications. Submit manufacturer's certification that products meet or exceed ASTM requirements. Submit two copies of certification to the Engineer.

1.4.03 Record Drawings. Submit record documents that record location of pipe runs, connections, manholes, and invert elevations. Identify locations of and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Manufacturers shall be as shown below based on type of pipe being installed.

Pipe Type	Recommended Manufacturers
Reinforced Concrete Pipe	Premarc, Copipe, National Concrete Products or approved equal
PVC and ABS Truss & Solid Wall Pipe	Lamson, Contech or approved equal
Fiberglass Mortar Pipe	Hobas or approved equal

2.2 MATERIALS.

2.2.01 Pipe. Sewer lines and laterals from 4 to 6 inches (10.2 to 15.2 cm) in diameter shall be solid wall ABS or PVC pipe complying with ASTM D2751 (ABS pipe) or ASTM D3034 (PVC pipe).

Sewer lines 8 to 15 inches (20.3 to 28.1 cm) in diameter shall be ABS or PVC truss pipe complying with ASTM D2680. PVC truss pipe joints shall be push-on type with rubber gasket. ABS truss pipe joints shall be of the chemically welded type with a solid ABS coupling. Joints shall provide a watertight seal and shall be made in strict accordance with the manufacturer’s recommendation.

Sewer lines larger than 15 inches (28.1 cm) in diameter shall be reinforced concrete pipe conforming to ASTM C76 or PVC large diameter pipe conforming to ASTM

F949 or ASTM F1803. Reinforced concrete pipe shall have modified grooved tongue joints with rubber gaskets that shall conform to ASTM C443. Pipe tongue shall not be out of round by more than plus or minus 1/16 inch (1.6 mm) and rubber gaskets shall be fabricated from a high grade rubber-like compound having a minimum tensile strength of 1200 psi (8,273.7 kPa) and a 7-day water absorption by weight not to exceed 5 percent.. PVC large diameter profile pipe shall be manufactured in accordance with ASTM F949 or ASTM F1803. Joints shall be the bell and spigot type.

Fiberglass mortar pipe, where used, shall conform to ASTM D3262. Steel for steel casing pipe shall be Type E or S, Grade B in conformance with ASTM A53.

2.2.02 Pipe Accessories. Fittings shall be of the same material as pipe molded or formed to suit pipe size and end design, in required tee and wyes.

2.2.03 Joint Compound. Joint compounds used to seal concrete reinforced sewer pipe shall be of a flexible Type I (Asbestos free) in compliance with ASTM D4586. Acceptable manufacturers include Sealtight or equal. Do not use cement grout.

2.2.04 Precast Manholes. Manholes shall be pre-cast concrete or fiberglass with rubber boot connections to sewer lines. Refer to Specification Section 02600 – Manholes.

PART 3 EXECUTION

3.1 INSPECTION. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION. Correct over-excavation with sand. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 INSTALLATION. Install pipe, fittings, and accessories in accordance with ASTM C12. Seal joints watertight. Lay pipe to slope gradients noted on Drawings. Install bedding at sides and over top of pipe as shown on the Drawings. Do not displace or damage pipe when compacting.

Reinforced concrete pipe joints shall be sealed with a flexible joint compound prior to backfill.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. Compaction testing shall be performed in accordance with Section 5.13 of the MDOT Standard Specifications for Construction.

3.4.02 Exfiltration Method Procedures. The section of sewer to be tested shall be sealed by inserting inflatable rubber bags in the pipes or by other means approved by the Engineer, and then water shall be introduced into a manhole until the section is completely filled. The Contractor shall fill the pipe to the test level prior to the time of exfiltration testing to permit normal absorption into the pipe walls.

Throughout the test period of at least 1 hour, the water level in the upper manhole shall be maintained at least 24 inches (61 cm) above the crown of the upper end of the pipe or at least 24 inches (61 cm) above the ground water table, which ever is higher. The length of pipe tested shall be limited so that the pressure on the center line of the lower end of the section tested shall not exceed 6 feet (1.8 m) of water column.

Exfiltration leakage shall not exceed 200 gallons per inch of pipe diameter per mile per day (185.2 l/cm/km/day) of sewer pipe, including manholes in the test section.

3.4.03 Infiltration Method Procedures. The section of sewer to be tested shall have been trench backfilled and the tests conducted by including infiltration conditions by jetting the sewer trench for a sufficient length of time to insure that the water level in the trench is minimum of 24 inches (61 cm) over the crown of the sewer pipe at the upper end of the pipe. The test must be performed before existing sewers are connected and before sewage flow is allowed in the sewers.

Infiltration flow shall be measured by a 90 degrees V notch weir with free fall discharge or other means acceptable to the Engineer. Infiltration leakage shall not exceed 200 gallons per inch of pipe diameter per mile per day (185.2 l/cm/km/day) of sewer pipe, including manholes in the test section.

3.4.04 Air Testing Method Procedures. The section of sewer to be tested shall have been trench backfilled and cleared. Pneumatic plugs (having a sealing length equal to or greater than the diameter of the pipe to be tested) placed in both ends of the pipe to be tested shall be inflated to 25 psi (172.4 kPa). The sealed sewer pipe shall then be pressurized to 4 psi (27.6 kPa) above the average backpressure of ground water over the sewer pipe and the air pressure allowed to stabilize for at least 2 minutes.

After the stabilization period, the line shall be pressurized to 3.5 psi (24.1 kPa) and the time in minutes measured for pressure to drop to 2.5 psi (17.2 kPa). If ground water is present, the air pressure within shall be increased to 3.5 psi (24.1 kPa) above the level of ground water and the drop of 1 psi (6.9 kPa) of air pressure measured in minutes.

Air testing techniques shall be in accordance with the latest ASTM standard practice for testing sewer lines by low-pressure air test method for the appropriate pipe material.

Air leakage test results shall equal or exceed the times allowed based on sewer pipe diameter and length as specified in the Low Pressure Air Test Tables for concrete pipe sewer per ASTM C924 and plastic gravity sewer per ASTM F1417.

3.4.05 Inspection. Request inspection prior to placing bedding.

End of Section

SECTION 02533

PIPE CLEANING AND TELEVISING

PART 1 – GENERAL

1.1 SUMMARY. Section includes the extent of cleaning and inspection work by closed circuit television of sewers or underground pipe systems.

1.2 SUBMITTALS. Submit in accordance with Specification Section 01080, Project Submittals covering the items included under this Section.

Owner Coordination: The Contractor shall coordinate pipe cleaning and televising work with DWSD SWWTP operations. The Contractor shall submit a coordination plan indicating related segments that will be affected by the Work. Provide schedule and detailed sequence of cleaning and televising work. Indicate impact of work on DWSD operations.

Inspection Report: After completion of Work under this Section, Contractor shall furnish to Engineer ten copies of a complete bound report of the television inspection and photographs taken during the televising of the pipe system. The report shall include written logs of each section of pipe televised, giving specific details as to service connections, broken, or crushed pipe, defective joints, misalignment in line and grade, water infiltration, root growth, and any other points of interest noted during the inspection. The television inspection DVD(s) shall be given to Engineer as part of the inspection report or as they are completed, upon request of Engineer. All DVD’s shall be labeled to describe the reaches of pipe contained in the recording, including manhole numbers or access locations, if available.

The inspection report shall be prepared and submitted in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.3 QUALITY ASSURANCE. Qualifications: Firms regularly engaged in the cleaning and televising of pipe systems for not less than five years. Firms shall submit references at the request of Engineer.

PART 2 - PRODUCTS

2.1 EQUIPMENT.

2.1.01 Cleaning Equipment. The equipment used for pipe cleaning shall be capable of removing all dirt, grease, rocks, roots, and other deleterious materials. The equipment selected by Contractor shall not damage the pipe system.

Equipment may include high-velocity water jetting equipment, vacuum machines, hydraulically propelled equipment, or mechanically powered equipment. Roots, large debris, and heavier deposits shall be removed with appropriate equipment.

If a rodding unit is used, it shall be able to pull brushes, swabs, and other cleaning equipment as well as the television camera. The rodding unit shall have a footage meter attached so that the location of the cleaning tools and/or television camera will be known at all times.

Necessary pulleys and supports shall be installed so as not to restrict the cleaning operation or damage existing equipment, structures, or materials. Where bucket machines and buckets are to be used, caution should be taken that a proper sized flexible cable be used so that cable breakage will not occur.

Cleaning equipment capable of cleaning lengths up to 1,000 feet shall be provided. Equipment must be able to clean the length with vehicular access to one location only.

2.1.02 Televising Equipment. The television camera used for the inspection shall be one specifically designed and constructed for inspection of pipe systems and shall be capable of operating under 100 percent humidity conditions.

The camera shall be of panning, rotating, tilting, and capable of viewing into lateral connections. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe.

All television inspection shall be recorded on DVD, which shall be turned over to Engineer. The recording must be made on a continuous running DVD on which sound and video information can be recorded. The DVD must contain a continuous record of the pipe section from access to access. The speed and electronics of the DVD shall be equal to that which can be played back on a standardized DVD player. The recording shall be made on a slow play format.

PART 3 - EXECUTION

3.1 PREPARATION. Cleaning Precautions: During pipe cleaning operations, satisfactory precautions shall be taken in the use of cleaning equipment.

When hydraulically propelled cleaning tools or tools that retard the flow in the pipe line are used, precautions shall be taken to ensure that the water pressure created does not damage or cause flooding. It is the sole responsibility of Contractor to avoid, clean or repair any damages which result from back-flushing the pipe.

When possible, the flows in the pipe shall be utilized to provide the necessary pressure for hydraulic cleaning devices. When additional water from fire hydrants or hose bibs is necessary to avoid delay in normal work procedures, the water shall be conserved and not used unnecessarily. Use of hydrants shall be approved by Engineer prior to utilization. No fire hydrants shall be obstructed in case of a fire in the area served by the hydrant.

3.2 PIPE CLEANING

3.2.01 General. Pipe cleaning shall include all Work required to clean pipes for inspection by closed circuit television. Work included in cleaning of pipes shall include providing necessary equipment and personnel for dislodging material from the pipe, removal of the debris from the system, and the transport and disposal of debris removed. Engineer will not provide a disposal site.

3.2.02 Removal and Disposal of Debris. All sludge, dirt, sand, rocks, grease, roots, and other solid or semisolid material resulting from the cleaning operation shall be removed at the downstream access of the section being cleaned. Contractor shall be responsible for proper and legal disposal of all debris resulting from the cleaning operation.

3.2.03 Acceptance of Pipe Cleaning. Acceptance of pipe line cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of Engineer. If the television inspection shows the cleaning to be unsatisfactory, Contractor shall be required to re-clean and re-inspect the pipe line, until the cleaning is shown to be satisfactory.

3.3 TELEVISION INSPECTION.

3.3.01 General. Under this Work, Contractor shall furnish all materials, labor, equipment, and all else necessary for performing a television inspection of the pipe.

The view seen by the television camera shall be transmitted to a monitor. The stationing of the television camera shall be continuously displayed on the television monitor while the pipe line is inspected. Engineer shall have access to view the television screen at all times.

3.3.02 Televising Procedure. The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to allow examination and documentation of all points of infiltration, cracked, or crushed pipe, defective joints, misalignment of line and grade, service lateral connections, or other points of interest noted during the inspection.

3.4 FIELD QUALITY CONTROL. Television Inspection Reporting: Two sets of printed records shall be kept by Contractor and will clearly show the location in relation to an adjacent access of each point of significance observed during the inspection. One set of this information shall be turned over to Engineer upon the completion of the inspection of each line. Contractor shall hold the second copy of the information until completion of Project, at which time it shall be neatly assembled and turned over to Engineer.

End of Section

SECTION 02600

MANHOLES

PART 1 - GENERAL

1.1 SCOPE. This section includes all manholes for sewers including entrance manholes, blow off wells, air release manholes, standard sewer manholes, drop manholes and interceptor sewer manholes. Emphasis is on the use of pre-cast concrete manholes.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society of Testing and Materials) A48 - Specification for Gray Iron Casting.

ASTM C32 - Specification for Sewer and Manhole Brick (Made for Clay or Shale).

ASTM C33 – Specification for Concrete Aggregates.

ASTM C150 - Specification for Portland Cement.

ASTM C207 – Specification for Hydrated Lime for Masonry Purposes.

ASTM C443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

ASTM C478 – Specification for Precast Reinforced Concrete Manhole Sections.

ASTM C923 - Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and pipes.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit shop drawings and product data on precast manholes, wells and pits along with related piping and accessories. Provide Manufacturer's written instruction for installing resilient connector.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Precast Concrete Manholes. Manholes shall be leak-tight and shall be constructed of precast units as shown on the Drawings according to ASTM C478.

Base shall be precast concrete or cast-in place. Tops shall be accurately shaped by ring forms to suit riser sections. Walls barrels and cones shall be precast concrete or cast-in place.

Top of Cone shall be reinforced concrete grading rings (preferred) or brickwork for adjusting frame to match finished surface (not to exceed 11 in. (27.9 cm)).

Manhole diameter shall be as indicated on the drawings.

Precast manhole sections shall comply with ASTM C478-85a with the following modifications:

Wall thickness shall be as indicated on drawings.

Cement shall comply with ASTM C150, Type II.

Joints between sections shall be rubber gaskets as per ASTM C443.

Steps shall be set accurately as indicated and specified

Cones and Conical Transitions shall be similar in design and construction to riser sections and as indicated. Flat Club tops as indicated.

During manufacture cast and build, resilient connectors for pipe connections, and holes for future pipe connections into bases.

Cure precast manhole sections by subjecting to saturated steam at temperature between 100 degrees F and 130 degrees F (38 degrees C and 55^0 C) for 12 hours or more. Cast or drill only 2 lift holes in each section. Mark clearly date of manufacture and name or trademark of manufacturer on insides of walls on all sections. Acceptance shall be on based of material tests and product inspection.

2.2.02 Fiberglass Manholes. Fiberglass reinforced polyester manhole shall be manufactured from commercial grade polyester resin or other suitable polyester or vinyl ester resins, with fiberglass reinforcements. Manhole shall be a one piece unit conforming with ASTM D3753 as manufactured by LFM or approved equal.

Manhole shall have resin fiber-reinforced bottom of 1 ½ inch (3.8 cm) minimum thickness and shall have a minimum 3 inch (7.6 cm) anti-flotation ring.

Manhole shall have 6 inches (15.2 cm) of concrete grade rings or brick between frame and cover and fiberglass structure.

Manholes shall be anchored in accordance with manufacturers recommended method to prevent floating. Concrete anchoring or rock anchors are acceptable.

Fiberglass manholes must have the ability to be height adjustable with the use of a height adjustment ring. Height adjustment can be made as a field operation without the use of uncured resins or fiberglass layups. Fiberglass manholes must maintain all load and soundness characteristics required by ASTM D3753 after height adjustment has occurred.

2.1.03 Portland Cement. Shall be ASTM C150, Type II.

2.1.04 Hydrated Lime. Shall be ASTM C207, Type S.

2.1.05 Sand. Shall be ASTM C33, Fine Aggregate, except all passes No. 8 sieve.

2.1.06 Brick. Shall be ASTM C32, Grade SS, but mean of five tests for absorption not to exceed 8 percent by weight.

2.1.07 Frames and Covers. Manhole cover and frame for all manholes, precast concrete, fiberglass, or cast in place, shall be of cast iron construction as per standard details. As indicated on the Contract Drawings, machine contact surfaces to prevent rocking.

Contractor shall furnish and install Type 304 stainless steel manhole designation tags, bolts, nuts and lock washers for each manhole. A list of the characters on the tags shall be provided by the Engineer. The nuts and bolts shall be counter-sunk to be flush with surrounding material.

2.1.08 Bituminous Waterproofing Material. Acceptable products include:

> No. 46-449 Heavy Duty Black made by Tnemec Company, Inc., North Kansas City, MO.
>
> No. 35-J-lG Hi-Build Bituminous Coating made by Mobil Chemical Company, Edison, NJ.
>
> Bitumastic Super Service Black made by Koppers Company, Inc., Pittsburgh, PA.; or acceptable equivalent.

2.1.09 Plastic Coated Steel Steps. PS2-PFS Manhole Steps made by M.A. Industries, Inc., Peachtree City, GA., or approved equal. Steps should be of type driven into preformed holes or embedded plastic inserts.

All steps shall be capable of resisting a minimum horizontal pull out load of 400 pounds (181.8 kg) and a minimum vertical load of 800 pounds (363.6 kg) without loosening or damaging.

2.1.10 Joints. Install rubber gaskets between precast sections to comply with ASTM C443.

Resilient connectors (rubber boots) between pipes and precast sections shall be per ASTM C923, and conforming to manufacturer's standards. Connectors using castings and bolts with non-resilient bearing are NOT ACCEPTABLE.

Rubber ring waterstops for pipe-to-manhole joints shall be of resilient material that will fit snugly over pipes and held firmly against pipe surface by means of a mechanical take-up device which, when tightened, will compress resilient material or by a stretch fit. Waterstop shall be designed and installed so that leakage between pipe and manhole is minimized. Materials and manufacture of waterstops conform to applicable provisions of the ASTM Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes, Designation C923.

Non-shrink mortar for pipe connections to existing manholes shall be Masterflow 713 Grout made by Master Builders, Cleveland, OH; Five Star Grout made by U.S. Grout Corp., Old Greenwich, CT; Upcon made by Upco Co., Cleveland, OH; or an approved equal.

2.1.11 Mixes. Concrete shall have a minimum 3000 psi (20,689.3 kPa) compressive strength at 28 days or as defined in drawings. See Master Specification Division 3 – Concrete.

Cement Mortar for laying brick and block in manholes shall be mixed in the proportion of 2 parts Portland Cement to 1 part hydrated lime to 9 parts sand. Use sufficient water to form a workable mixture of damp mortar, just short of "balling".

Mortar mixed by hand shall be prepared in a suitable clean, water-tight box. The ingredients, except water, shall be first thoroughly mixed dry until of uniform color; then water shall be added and the mixing continued until mortar is of proper consistency and uniform texture is produced.

No retempered mortar that has been mixed for more than thirty minutes shall be used in the work. No cement mortar shall be mixed when the temperature is below 30 degrees F (-1.1 degrees C), without heating the sand and water.

Mortar for plugging lift holes shall be mixed at 2 parts Portland Cement to 3 parts sand by volume with sufficient water.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 Erection of Precast Sections. Set vertical with sections and steps in alignment. Set bases true to line and elevation. Install rubber gaskets in joints between sections conforming to manufacturer's standard. Plug lifting holes with mortar. Hammer mortar into hole until dense and excess of paste appears, then smooth flush with adjoining surface.

3.1.02 Laying Brickwork and Grading Rings. Moisten bricks, before laying. Moistening of grading rings is NOT PERMITTED. Lay bricks and grading rings in full bed and joint of mortar without subsequent grouting, flushing or filling; bond thoroughly.

3.1.03 Plastering and Curing Brick Masonry. Plaster outside faces with mortar for brick: 1/4" (6mm) to 3/8" (10mm) thick. Moisten brick masonry before application of mortar. Spread and trowel plaster carefully. Check after hardening by tapping for bond and soundness. Remove and replace unbonded and unsound plaster. Protect from too rapid drying by moist burlap or as approved. Protect from weather and frost.

3.1.04 Jointing and Connections. Joints between precast sections, and between pipes and precast sections shall conform to related standards and manufacturer's instruction.

When installing rubber ring water stops for pipe-to-manhole, hold firmly against pipe surface by mechanical take-up device to compress resilient material when tightened. Install to minimize leakage.

Apply non-shrink mortar according to manufacturer's instruction. Close openings for future connection with concrete or brick masonry bulkhead as indicated.

3.1.05 Coating. Give exterior surfaces two heavy coats of bituminous waterproofing material. Apply by brush or spray according to manufacturer's instructions. Special coating requirements are specified in Master Specification Section 09900 - Painting.

3.1.06 Setting Frames and Covers. Set frames with top conforming to finished ground or pavement surface as indicated and directed. Set circular frames concentric with top of concrete or masonry. Set frames in full bed of mortar to fill and make watertight space between masonry top and bottom flange of frame. Place thick ring of mortar extending to outer edge of concrete or masonry, around bottom flange. Finish mortar smoothly and give a slight slope to drain water away from frame. Place concrete collar around frame when placing permanent pavement as indicated. Place covers in frames on completion of work.

Install manhole designation, tags in location recommended by Owner's representative according to manufacture's instructions. Provide secondary manhole designation working on interior face of frame.

3.1.07 Installing Steps. Embed steps in wall during casting. Steps shall be installed in a vertical row on centers.

3.2 FIELD QUALITY CONTROL.

3.2.01 Inspection. Inspect for visible leakage after backfill with ground water at normal level. Locate visible leakage inside manhole and repair leaks.

End of Section

SECTION 02620

WATER MAIN SERVICES

PART 1 - GENERAL

1.1 SCOPE. This Section covers buried piping not otherwise specified as steel or reinforced concrete pressure pipes, fittings, valves, service connections, valve wells, thrust blocks, thrust restraining, polyethylene encasement, appurtenances and accessories complete as shown on the drawings and specified herein and other related sections of these Specifications.
1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified herein, all water main work shall be done according to the applicable portions of the Standard Specifications prepared by: the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), the American Water Works Association (AWWA), the National Sanitation Foundation (NSF), the City of Detroit, Department of Public Works Specifications and Standards, and the Michigan Department of Transportation (MDOT). Particularly, the Contractors attention is directed to the latest editions of the following standards at the time of bid:

ANSI/AWWA C104/A21.4 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

ANSI/AWWA C105/A21.5 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

ANSI/AWWA C110/A21.10 - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3in through 48in for Water and other liquids.

ANSI/AWWA C111/A21.11 - American National Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

ANSI/AWWA C115/A21.15 - American National Standard for Flanged Ductile-Iron or Gray-Iron Threaded Flanges.

ANSI/AWWA C150/A21.50 - American National Standard for Thickness Design of Ductile-Iron Pipe.

ANSI/AWWA C151/A21.51 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

ANSI/AWWA C153/A21.53 - American National Standard for Ductile-Iron Compact Fittings, 3 inches (7.6 cm) through 24 inches ((61.0 cm), and 54 inches (137.2 cm) through 64 inches (162.6 cm) for Water Service.

AWWA C600 AWWA - Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

ANSI/AWWA C653. AWWA - Standard for Disinfecting Water Mains.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Contractor shall have 5 years documented experience successfully installing water mains and related valves and equipment with sufficient equipment and crews to install Work without delays.

1.3.02 Tolerances. Water main installation shall be within 0.01 foot of the design elevation unless otherwise authorized in writing by the Engineer.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit product data on all water main pipes, fittings, valves, fire hydrants, service connections, valve wells, mechanical thrust restraints, appurtenances and accessories. Submit shop drawings and calculations for all mechanical thrust restraints, thrust clocks, and manholes, wells, and pits.

1.4.02 Certifications. For all furnished materials, the Contractor shall furnish a sworn statement that the inspection and all tests required have been made and that the results comply with the requirements of the applicable standards. All affidavits of compliance shall be certified by a registered professional Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING PRODUCT.

1.5.01 Delivery of Materials. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes, or other abrasive tools shall not be permitted to come into contact with the polyethylene lining.

1.5.02 Handling of Materials. Load and unload piping using suitably approved hoist and skidding. Piping shall not be dropped, bumped or allowed to impact against itself. The Engineer shall reject damaged piping.

Lifting devices shall be suited to the Work and shall protect surfaces from damage.

1.5.03 Storage of Materials. Pipe shall be stored in a manner to minimize infiltration of dirt, debris and other extraneous materials.

Piping materials shall not be stacked higher than 4 feet (1.2 m). Suitable racks, chairs and other supports shall be provided to protect preformed pipe mating surfaces from damage. Store bottom tiers off the ground, alternate tiers and chock tier ends.

Store all hydrants, valves, wells and prefabricated structures off the ground, drained and kept free of water to protect against damage from freezing. Hydrants, valves, wells, their accessories and appurtenances shall be kept in their original containers until ready for installation.

All joints and sealing materials subject to ultra-violet or ozone attack and used in the water main system shall be protected from the sunlight, atmosphere and weather, stored in suitable enclosures until ready for installation.

1.5.04 Damaged Materials. Pipe and fittings in which the lining has been damaged shall be replaced.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

2.1.01 Dimensions. Ductile iron pipe shall be designed and manufactured in accordance with the latest revision of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51, respectively.

2.1.02 Marking. All manhole covers and valves shall have cast the letters DWSD, the manufacturer's name or mark, the year of the manufacturer and the size. Other markings, in lieu of cast markings, shall be approved by the Engineer.

2.2 ACCEPTABLE MANUFACTURERS.

2.2.01 Pipe, Valves and Fittings. Acceptable manufacturers for ductile iron pipe and appurtenances include Ductile Iron Pipe, U.S. Pipe, American, Clow or approved equal.

2.2.02 Roadway Boxes. Acceptable manufacturers include Traverse City Iron Works (A-295 Three Piece Screw Type); Clow (AF2450), Tyler (Series 6860), East Jordan Iron Works (6860 Series) or approved equal.

2.2.03 Corporation Stops. Acceptable manufacturers include Hays, Crane, Mueller, Ford, or approved equal.

2.2.04 Hydrants. Acceptable manufacturers include East Jordan Iron Works or approved equal.

2.2.05 Service Clamps. Acceptable manufacturers include Mueller or approved equal.

2.2.06 Curb Stops. Acceptable manufacturers include Hays, Ford, Mueller, or approved equal.

2.2.07 Curb Box. Acceptable manufacturers include Mueller or approved equal.

2.2.08 Restrained Mechanical Joints. Acceptable manufacturers include American AMJ coupled Joint and, Griffin MECH-LOK. Field Cut Spigot shall be EBAA Iron Megalug Series 1100. (4 to 20 inch (10.2 – 50.8 cm).

2.3 MATERIALS.

2.3.01 Pipe. Shall be ductile iron pipe, Thickness Class 56 as defined in ANSI/AWWA C150/21.50.

As an alternative with approval of Engineer, DI pipe shall conform to ANSI/AWWA C150/A21.50, American National Standard for the Thickness Design of Ductile Iron Pipe and the National Sanitation Foundation Standard No. 61. The material and properties used shall conform to ANSI/AWWA C151/A21.51, Ductile Iron Centrifugally Cast, for Water or Other Liquids. In addition, the pipe shall be pressure rated in accordance with the ANSI/AWWA standards and meet the minimum pressure classes as follows:

Ductile Iron Pipe, 12 inch Diameter or Smaller	Pressure Class 350
Ductile Iron Pipe, 14 inch Diameter or Greater	Pressure Class 250

2.3.02 Fitting. Shall meet ANSI/AWWA C153/A21.53 except 350 psi (2413 kPa) pressure.

2.3.03 Push-on Joints. Shall meet ANSI/AWWA C111/A21.11. except gaskets shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable.

2.3.04 Restrained Push-on Joints.

4 to 12 inch (10.2 – 30.5 cm)	U.S. Pipe Field Lok Gasket, or American Fast-Grip.
4 to 20 inch (10.2 – 50.8 cm)	EBAA Iron Megalug Series 1700.

4 to 64 inch (10.2 – 162.6 cm)	American "Flex-Ring", “Field Flex-Ring”, or "Lok--Ring"; Clow "Super-Lock"; U.S. Pipe "TR Flex"; or Griffin "Snap-Lok". Sets crews bearing on the pipe wall will not be acceptable.

2.3.05 Flanged Joints. Shall meet ANSI/AWWA C115/A21.15.

2.3.06 Flanges Ductile Iron. Shall meet ANSI/AWWA C115/A21.15.

2.3.07 Bolts. Shall be ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch (6.4 – 12.7 mm) beyond outer face of nut.

2.3.08 Nuts. Shall meet ASTM A307, hexagonal, ANSI/ASME B18.2.2, heavy semi-finished pattern.

2.3.09 Gaskets. Shall be ASTM D1330, Grade I rubber, full face type, 1/8 inch (3.2 mm) thick.

2.3.10 Mechanical Joints. Shall be ANSI/AWWA C115/A21.1, except gaskets shall be neoprene or other synthetic rubber. Natural rubber will not be acceptable.

2.3.11 Restrained Mechanical Joints. Shall be factory prepared.

2.3.12 Wall Castings. Mechanical joint with water stop/thrust collar and tapped holes; single casting or fabricated ductile iron. All holes shall be sized in accordance with the details on the drawings and shall be provided with removable plugs. Plan end and flanged end wall castings where indicated on the Drawings.

2.3.13 Mechanical Joints with Tie Rods. See details on the drawings. Tie Rods shall meet ASTM A307. Steel Pipe shall meet ASTM standard weight. Washers shall meet ANSI B18.22.1 plain steel.

2.3.14 Threaded Connections. Shall comply with ANSI/ASME B1.20.1, NPT. Provide boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.

2.3.15 Mechanical Couplings. Couplings shall be Dresser “Style 38”, Smith Blair “441 or 411 Flexible Coupling”, Brico Depend-O-Lok, or Romac “Style 501”; without pipe stop. Gaskets shall be Oil-resistant synthetic rubber.

2.3.16 Grooved Couplings. Grooved pipe ends shall meet dimensions conforming to AWWA C606, Table 5 for rigid joints.

Shouldered pipe ends shall meet dimensions conforming to AWWA C606, Table 4. Flanged and grooved pip w/ couplings will not be permitted for underground use, unless written approval by the engineer is obtained.

2.3.18 Tapping Saddles. Shall be ductile iron, with steel straps and rubber sealing gasket, 250 psi (1723.8 kPa) pressure rating.

2.3.19 Tapping Sleeves. Mechanical joint sleeves shall be furnished complete with valve, stops, caps, plugs and joint accessories as indicated on the Plan. The sleeve shall be of a 2-section type.

2.3.20 Shop Coating and Lining. Cement Mortar Lining shall comply with ANSI/AWWA C104/A21.4.

Universal Primer shall be Ameron "Amercoat 180 Synthetic Resin Coating", Carboline "888 Primer", or Tnemec "Series 37H Chem-Prime H.S."

Asphaltic Coating shall meet Manufacturer's standard.

Liquid Epoxy shall meet NSI/AWWA C210.

Rust-Preventive Compound shall be provided by Houghton "Rust Veto 344".

2.3.21 Polyethylene Tube. Shall be seamless, ANSI/AWWA C105/A21.5

2.3.22 Adhesive Tape. Adhesive tape shall be a general purpose adhesive tape 2 inch (5.1 cm) wide and approximately 10 mils thick, such as Scotchrap No. 50, Polyken No. 900 or Tapecoat CT. Tape used for repair of damage to the polyethylene shall possess a life expectancy equal to that of the polyethylene.

2.4 SHOP COATING AND LINING. The interior of all pipe and fittings for water service shall be cement mortar lined double thickness with asphaltic seal coat according to ANSI/AWWA C104/A21.4.

The exterior surfaces of all pipe and fittings which will be exposed in interior locations shall be primed. Flange faces shall be coated with rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

2.5 STRUCTURES. Material for water main structures shall conform to the following requirements:

Precast Concrete Units shall meet ASTM C478, circular with circular or elliptical reinforcement as detailed. Provide lifting holes in precast units where indicated.

Steps shall be Steel Reinforced Plastic using a suitably approved co-polymer polypropylene conforming to ASTM D2146, Type II, Grade 49108 with 3/8 inch (9.5 mm) minimum diameter deformed reinforcing bar conforming to ASTM A615, Grade 60.

Covers and Frames shall be Class 30, ASTM A48 gray iron castings. The castings shall be nearly made and free from cracks, cold sheets, holes and other defects. Surfaces of castings shall be ground to assure proper fit and to prevent rocking. Units shall be frostproof and shall be provided with tapping screws and anchors.

Bolts, studs, and nuts shall conform to the requirements of AWWA C500 and the ASTM standards. Bronze shall meet ASTM B98. Steel shall meet ASTM A307, Grade B. Cadmium Plating shall meet ASTM A165, Grade N.S. Zinc Coating shall meet ASTM A153 or A164, Type G.S. Tee head bolts and nuts shall be high strength, low alloy steel conforming to ANSI/AWWA C111/A 21.11.

2.6 POLYETHYLENE ENCASEMENT. Polyethylene material, in tube form shall be used to encase ductile iron pipe. Polyethylene encasement materials shall be manufactured in accordance with ASTM Specifications D4976. Polyethylene encasement shall be linear low-density polyethylene Film Group 2, Tensile Strength 3,600 psi (24,822 kPa) and Elongation 800%. Polyethylene tube material shall have a minimum thickness of .008 (8-mils).

Adhesive tape shall be used to repair polyethylene and seal joints.

PART 3 - EXECUTION

3.1 INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; spigot ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site of the work.

3.1.01 Excavation and Bedding. Prior to the installation of any water main piping or materials, examine all trenches and other excavations for the proper grades, lines, levels and clearances required to receive the new Work. Ascertain that all excavation bottoms, compacted subgrades and pipe bedding are adequate to receive water main materials to be installed. Correct all defects and deficiencies before proceeding with the work. Refer also the Master Specification Section 02711, Excavating, Filling, and Grading.

3.1.02 Existing Water Mains. Expose the existing water main piping and structures to which the new Work is to be connected and provide notification of source. After verification of the vertical and horizontal locations of the existing system, the necessary adjustments required to align the new water main work with the existing system, will be determined.

3.2 PREPARATION. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter prior to installation. Before jointing, all joint contact surfaces shall be wire brushed if necessary, wiped clean, and kept clean until jointing is completed.

Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

3.2.01 Pipe Ends. Remove all lumps, blisters excess coatings from the socket and plain ends of pipe. Wire brush and wipe clean the outside surfaces of all plain ends and the inside surfaces of all socket ends before installation. Any pipe or fitting which has acquired a coating of mud or other adhesive foreign material shall be scrubbed clean with heavily chlorinated water.

3.2.02 Examination of Materials. All pipe fittings, valves, hydrants, accessories and appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective or damaged materials shall be marked and held for inspection. Damaged materials are subject to rejection.

3.2.03 Pipe Plugs. During and after laying operations, no debris, clothing or other materials shall be placed in the pipe. During the progress of all water main Work, watertight plugs shall be carried along and inserted in the end of each pipe as it is laid to prevent foreign matter or rodents from entering the pipe. This watertight plug shall be fastened in the end of the water main in such a manner as to prevent it from floating or being otherwise displaced whenever construction operations are temporarily halted, such as at noon or at the end of the days Work.

3.3 INSTALLATION.

3.3.01 Cutting Pipe. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

All cutting of gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.

Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be permitted. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be permitted.

3.3.02 Pipe Linings and Coatings. When cutting pipe or fittings, care shall be taken to prevent damage to linings and coatings. Damage to linings shall be cause for rejection of the complete Section. Damage to exterior coatings shall be corrected to original Specifications.

3.3.03 Gaskets. Where pipe using a resilient gasket to effect the seal is cut, the cut pipe end shall be tapered at a 30-degree angle with the centerline of the pipe, and ground smooth, on the outside end to remove any sharp edges or burns which might damage the gasket.

3.3.04 Alignment. Piping shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the values stipulated in Table 4 or Table 5 of AWWA C600, unless specially designed bells and spigots are provided.

Either shorter pipe sections or fittings shall be installed where required to conform to the alignment or grade indicated on the drawings.

3.3.05 Laying Pipe. Pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions.

Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water from entering the pipe.

Pipe shall be laid with the bell ends facing the direction of laying, except when reverse laying is specifically authorized by the Engineer.

3.3.06 Field Joints. Joints in buried locations shall be push-on type unless otherwise indicated on the drawings. Bells on wall castings and wall sleeves shall be mechanical joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the drawings.

Where acceptable, grooved couplings may be used instead of flanges, provided that rigid grooving is used to preclude longitudinal pipe movement and angular deflection at joints. Fittings, valves, and equipment installed using grooved couplings shall be adequately supported and blocked or restrained to prevent rotation.

3.3.07 Mechanical Joints. Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Over tightening of bolts to compensate for poor installation practice will not be permitted.

The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top (or side for vertical piping) center line. The top (or side) center line shall be marked on each flange and mechanical joint piece at the foundry.

3.3.08 Push-On Joints. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

Joints shall be made by means of a compression type push-on resilient gasket. Gasket shall be prelubricated before installation using a lubricant recommended by the pipe manufacturer. The seated joint shall be identified by the visible mark on the spigot of the installed pipe section.

When the temperature is above 60-degree F (15.6 degrees C), the spigot end of each cast iron pipe lead shall be forced tightly on the bell of the proceeding pipe.

When the temperature is below 60-degrees F(15.6 degrees C), the pipe shall be laid with the spigot end 1/16 inch (1.6 mm) from the face of the bell of expansion.

3.3.09 Sleeve-Type Coupling. Clean pipe ends for distance of 8 inches (20.3 cm). Use soapy water as gasket lubricant. Slip follower and gasket over each pipe to a distance of 6 inches (91.4 cm) from end and place middle ring on pipe end until centered over joint. Insert other pipe end into middle ring and bring to proper position in relation to pipe laid. Press gaskets and followers into middle ring flares. After bolts are inserted and nuts made fingertight, tighten diametrically opposite nuts by use of torque wrench of size and torque specified below:

TORQUE

Nominal pipe size Inch (cm)	Bolt diameter Inch (mm)	Maximum torque Ft-lbs (N – m)
3-24 (7.6 – 6.10)	5/8 (15.9)	75 (101.7)
30-36 (1/2 in./12.7 mm mid. Ring) (76.2 – 91.4)	5/8 (15.9)	65 (88.1)
30-36 (3/8 in./9.5 mm mid. Ring) (76.2 – 91.4)	5/8 (15.9)	70 (94.9)
30-48 (76.2 – 121.9)	3/4 (19.1)	80 (108.5)
48-72 (121.9 – 182.9)	3/4 (19.1)	90 (122.0)

After assembly and inspection and before backfill, coat exterior surfaces of buried couplings with heavy-bodied bituminous mastic.

3.3.10 Mechanical Couplings. Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations. A space of at least 1/4 inch (6.4 mm), but not more than 1 inch (2.5 cm), shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of the Engineer.

The interior surfaces of the middle rings shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining components shall be cleaned and shop primed with universal primer.

3.3.11 Grooved End Joints. Grooved couplings shall be installed in accordance with the coupling manufacturer's recommendations. Completed joints shall be rigid and shall not allow angular deflection or longitudinal movement. Except for closure pieces, field grooving of pipe will not be permitted.

Special care shall be taken when connecting to pumping equipment to avoid transmitting pipe stresses to the pump flanges. Piping shall be permanently supported to obtain accurate matching of piping and abutting pump flanges before bolts are installed in the flanges.

3.3.12 Polyethylene Encasement. Polyethylene encasement shall be installed on pipe and fittings at locations specified on the construction drawings. Although not intended to be a completely air and watertight enclosure, the polyethylene shall provide a continuous barrier between the pipe and the surrounding backfill.

Cut polyethylene tube to a length approximately 2 feet (61.0 cm) longer that the length of the pipe section. Slip the polyethylene around the pipe, centering it to provide a foot (30.5 cm) overlap on each adjacent pipe section, and bunching it accordion fashion until it clears the pipe ends.

After completing the joint, make the overlap. Pull the bunched-up polyethylene from the preceding length of pipe, slip it over the end of new length of pipe, and secure in place with one circumferential turn of tape plus enough overlap to assure firm adhesion. Then slip the end of the polyethylene from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Tape it in place. Take up the slack width to make a snug, but not tight, fit along the barrel of the pipe, securing the fold with short strips of adhesive tape at intervals of about 3 feet (91.4 cm) along the pipe barrel.

Repair any rips, punctures or other damage to the polyethylene with tape or with short length of polyethylene tube cut open, wrapped around the pipe, and secured with tape. Proceed with installation of the next section of pipe in the same manner.

Alternate Method: Cut polyethylene tube to a length approximately 1 foot (30.5 cm) shorter than the length of the pipe section. Slip polyethylene around the pipe, centering it to provide 6 inch (15.2 cm) of bard pipe at each end. Make polyethylene snug, but not tight; tape down and secure ends as described above.

Before making up a joint, slip a 3 feet (91.4 cm) length of polyethylene tube over the end of the preceding pipe section, bunching it accordion fashion. After completing the joint, pull the 3 feet (91.4 cm) length of polyethylene over the joint, overlapping the polyethylene previously installed on each adjacent section of pipe by at least one foot; make snug, tape down, and secure each end as described above.

Repair any rips, punctures, or other damage to the polyethylene as described above. Proceed with installation of the next section of pipe in the same manner.

Bend, reducers and offsets shall be covered with polyethylene in the same manner as the pipe.

Valves and other odd-shaped pieces which cannot practically be wrapped in a tube, shall be wrapped with a flat sheet obtained by splitting open a length of polyethylene tube. This sheet shall be passed under the valve and brought up around the body of the stem. Seams shall be made by bringing the edges together, folding over twice, and taping down. Slack with and overlaps at joints shall be handled as described above. Tape polyethylene securely in place at valve stem and other penetrations.

3.4 VALVES, HYDRANTS, FITTINGS, & APPURTENANCES INSTALLATION.

3.4.01 Valves. All valves shall be installed to the grade, lines, levels and locations indicated on the Plans.

Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.

Where required, valves shall be supported with special supports as indicated on the Plans and as approved by the Engineer. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.

3.4.02 Hydrants. All hydrants shall be installed plumb to the lines, levels, grades, and locations indicated on the Plans. Hydrants shall be set to the established grade, shall have their nozzles parallel to or at right angles to and facing the grade road box.

Where necessary to adjust for proper hydrant grade and location, the Contractor shall install additional fitting and spigot pipe between the water main road box.

The Contractor shall plumb all hydrants at the time they are set with the plumb line or other means acceptable. Upon substantial completion of cleanup, the Contractor shall recheck all hydrants for plumb and grade and shall make all adjustments as directed at this time. The Work of constructing fire hydrants shall not be considered complete until these final adjustments for plumb and grade have been made.

3.4.03 Valves Boxes. Install valve boxes to the grade, lines, levels, and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.4.04 Corporation Stops. Corporation stops shall be located on water main piping where indicated on the Plans, or as directed by the Engineer. Install a minimum of 2 corporation stops in each valve well.

One-inch tapping outlets shall be installed at approximately 20-foot (6.1 m) intervals along the entire length of the water main. These tapping outlets shall be constructed as detailed on the Plans and shall be positioned 45-degrees off vertical. The location of the tapping outlets shall be marked by means of No. 4 reinforcing rod. The rod shall be placed in a vertical position immediately adjacent to, but not touching, the water main and the top, 6 inches (15.2 cm) below finished grade.

3.4.05 Service Clamps. Where service clamps are to be installed, the entire circumference of the main shall be free of all loose material. Installation of the clamp and tapping of the main shall be in accordance with manufacturers recommendations.

3.4.06 Fittings, Strapping, and Lugged Pipe. Install all fittings to the lines, and levels. Installation of fittings shall be with the type of joint specified for piping. Fittings shall be provided with restraints as specified herein as required for a functional installation.

3.4.07 Fire Hydrant Approaches. Fire hydrant approaches shall consist of culvert pipe with end protection and a gravel approach. The culvert pipe shall be of the size and type shown on the Plans. The culvert pipe shall be installed to the existing or proposed grade of the drain with pipe bedding and backfill from a point 4 inches (10.2 cm) below the pipe to a point 12 inches (30.5 cm) above the top of the pipe, consisting of bank run sand meeting the requirements of MDOT Class II granular material and compacted to 95% of maximum unit weight. Each end of the culvert pipe shall be protected against erosion, as shown on the Plans. The gravel approach shall extend from the edge of the travel portion of the road to the fire hydrant and shall be a minimum of 10 feet (3.1 m) wide. The gravel approach shall consist of a minimum of 6 inches (15.2 cm) of compacted 22A or 23A aggregate, with calcium chloride applied at rate of 6 pounds per ton (3 kg per 1000 kg) of aggregate.

3.4.08 Water Main Structures. Construct water main valve wells and structures to the grades, lines and levels indicated on the Plans and as specified. Structures shall be completed with concrete bases, reinforcing, frames, covers, adjustment rings, etc. as shown and as required for a complete installation. Water main structures shall conform to the dimensions indicated on the Plans and as described below.

3.4.09 Precast Concrete Units. Construct as directed and as approved by the Engineer. Provide mortar joints struck smooth. Provide 2 to 4 courses of 8 inch (20.3 cm) brick at top of structure for future adjustment.

3.4.10 Brick Units. Prior to laying, all brick shall be thoroughly wetted and the surfaces allowed to dry only sufficiently to prevent slippage on the mortar.

Broken or chipped brick shall not be used on the faces of the structure.

Brick shall be laid in neat, even consecutive courses with full and close mortar joints. Courses shall be level throughout, except as shown or otherwise required. Stagger joints in adjoining courses by 1/2 a brick as nearly as practicable. At least 1 course in every 7 shall be stretcher courses with intervening courses laid as headers. Length of brick closure pieces shall be not less than the width of 1 whole brick and, wherever practicable, closures as headers, shall be made from whole brick.

Unless otherwise indicated, joints shall be not more than 2 inch (5.1 cm) thick and shall be of a uniform thickness throughout the structure. Joints shall be provided as required. Exposed surfaces shall be true and smooth. Rake all joints to receive plaster coat.

Prior to applying plaster coat, brick shall be thoroughly wetted with water and the surface allowed to dry sufficiently to effect proper bonding.

3.4.11 Concrete Block. Construct concrete block structures as directed and as approved by the Engineer. The first course of concrete blocks shall be placed on the prepared base or footings in a full bed of mortar. Mortar joints shall be full and close in all courses. Courses shall be level throughout. Stagger joints in adjourning courses by one-half the length of the block as nearly as practicable.

Joints shall be uniform in thickness throughout the structures. Strike all joints and properly point to provide true, smooth surfaces.

3.4.12 Plaster Coat. Cement mortar plaster coat shall be applied to the exterior surface of all gate wells and other water main structures that are not precast as indicated on the Plans. Plaster coat shall be 2 inch (5.1 cm) thick and shall be applied to the outer surfaces of the structures.

3.4.13 Castings. Provide and install to the elevations shown all cast iron covers, frames, adjusting rings, anchors, etc., indicated on the Plans and as required. Castings shall be set in a full bed of cement mortar 2 inch (5.1 cm) thick minimum. Mortar joints shall be struck smooth.

3.4.14 Steps. Install steps for structures of types and in locations indicated on the Plans. Steps shall be installed on 16 inch (40.6 cm) centers minimum.

3.4.15 Tapping Valve Assembly. Install all tapping valve assemblies of sizes and to the lines, elevations, locations and indicated on the Plans. The tapping sleeve shall be assembled around the main, and the tapping performed in strict accordance with the manufacturers recommendations. Tapping shall be accomplished without interruption of service.

3.4.16 Wall Castings. Wall castings shall be provided where ductile iron pipes pass through concrete walls. Alternate allowable wall and floor penetration types are indicated on the Drawings.

Where a flange and mechanical joint piece is to connect to a mechanical joint wall casting, the bolt holes in the bell of the wall casting shall straddle the top (or the side for vertical piping) center line of the casting and shall align with the bolt holes in the flange and mechanical joint piece. The top center line shall be marked on the wall casting at the foundry.

3.4.17 Reducers. Where indicated on the drawings, reducers shall be eccentric pattern, installed with the straight side on top so that air traps are not formed. All other reducers shall be concentric pattern.

3.4.18 Outlets. Where a 12 inch (30.5 cm) or smaller branch outlet is indicated and the diameter of the line pipe is at least twice the diameter of the branch, a tee, a factory welded-on boss, or a tapping saddle will be acceptable.

Gauge connections in ductile iron piping shall conform to Master Specification Section 15130, Indicating Devices

Connection of gauges to 6 inch (15.2 cm) and smaller ductile iron pipe shall be made using a tapping saddle, or a tee complete with blind flange drilled and tapped to accept the gauge piping specified. Connection of gauges to 8 inch (20.3 cm) and larger piping shall be made by means of a factory welded-on boss or a tapping saddle. Drilling and tapping of the pipe wall will also be acceptable, provided that the wall thickness, minus the foundry tolerance, at the point of connection equals or exceeds the wall thickness required for 4-thread engagement in accordance with Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.

3.4.19 Connections with Existing Piping. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from the dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, a 200 mg/L (ppm) chlorine solution.

3.4.20 Concrete Encasement. Concrete encasement shall be installed as indicated on the drawings. Concrete and reinforcing steel shall be as specified in the cast-in-place concrete section. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.4.21 Reaction Anchorage And Blocking. All exposed piping with mechanical couplings, push-on or mechanical joints, or similar joints subject to internal pressure shall be blocked, anchored, or harnessed to preclude separation of joints. All push-on and mechanical joint tees, Y-branches, bends deflecting 22-1/2 degrees or more, and plugs which are installed in buried piping (subjected to internal hydrostatic heads in excess of 30 feet (9.14 m)) shall be provided with suitable reaction blocking, anchors, joint harness, or other acceptable means for preventing movement of the pipe caused by internal pressure.

Concrete blocking shall extend from the fitting to solid undisturbed earth and shall be installed so that all joints are accessible for repair. The dimensions of concrete reaction blocking shall be as indicated on the drawings or as directed by the Engineer. If adequate support against undisturbed ground cannot be obtained, metal harness anchorages shall be installed to provide the necessary support. Metal harness anchorages shall consist of steel rods extending across the joint and securely anchored to pipe and fitting, or other adequate anchorage facilities shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, metal harness anchorages shall be furnished and installed by and at the expense of the Contractor.

Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as required by the drawings or as directed by the Engineer.

3.4.22 Leakage. All joints shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of the Contractor.

3.4.23 Outlets. In special cases as approved by Owner, outlets may be used in accordance with Master Specification Section15061, 3.14, Ductile Iron Pipe.

3.5 FIELD QUALITY CONTROL.

3.5.01 Pressure Test. Unless otherwise specified herein, the hydrostatic testing shall be performed according to ANSI/AWWA C-600. After the pipe has been laid and backfilled, the pipes shall be hydrostatically tested for leakage. The Contractor shall furnish the pumps, pipe connections, hydrants, valves temporary plus and bracing and any other necessary apparatus including gages and meters and all personnel necessary for conducting the test. Before applying the test pressure, all air shall be expelled from the pipe. If necessary to accomplish this, taps shall be made at points of higher elevation and afterwards plugged with brass plugs as approved by the Engineer. The test shall be made at a pressure of 150 psi (1,034.2 kPa) gage. The full pressure shall be held for at least 1 hour for piping 12 inch (30.5 cm) inside diameter and under and for 2 hours on piping 12 inch (30.5) inside diameter and larger. Any faulty pipe fitting, gate valves or other accessories which permit leaks during testing shall be replaced by the Contractor with sound material and the test shall be repeated until specified requirements are met. The maximum permissible leakage measured by water meter from the section of main tested under pressure, shall not exceed a rate of 11 U.S. gallons per inch diameter of main per mile of pipe in 24 hours for each section tested. Test sections will normally not exceed 1 mile (1.6 km) and in the event more than 1 mile (1.6 km) of water main is tested, the permissible leakage will remain at the amount determined for 1 mile (1.6 km) of pipe.

3.5.02 Water for Testing. Water for testing shall be obtained from a potable water supply. The Contractor shall provide all water required at his own expense and shall make all necessary arrangements with the authority that controls the source of water. The Contractor shall provide and remove temporary connections between the source water system and the mains constructed under this Contract. All temporary connections between the source of water system and the mains constructed under this Contract shall meet approval of the authority controlling the source water system and Public Health authorities having jurisdiction.

The Contractor shall provide all necessary pumping equipment; piping connections between the piping and the nearest available source of test water; pressure gauges; and other equipment, materials, and facilities necessary for the tests.

All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping retested by and at the expense of the Contractor.

End of Section

SECTION 02621

COMPRESSION TYPE FIRE HYDRANTS

PART 1 – GENERAL

1.1 SCOPE: This section covers breakable flange double nozzle, compression type fire hydrants. Hydrants shall be of a true compression type, opening against the pressure and closing with the pressure. The hydrants shall be in strict conformity with this specification.

1.2 PATTERNS**:** All necessary patterns required for the manufacture of the hydrants shall be furnished by the manufacturer and shall remain his property.

1.3 GENERAL:

1.3.01 Governing Standards. Unless otherwise specified herein, all water main work shall be done according to the applicable portions of the Standard Specifications prepared by: the American National Standards Institute (ANSI), the American Society for Testing and Materials (ASTM), the American Water Works Association (AWWA), the National Sanitation Foundation (NSF), the City of Detroit, Department of Public Works Specifications and Standards, and the Michigan Department of Transportation (MOOT). Particularly, the Contractors attention is directed to the latest editions of the following standards at the time of bid:

ANSI/AWWA C104/A21.4- American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

ANSI/AWWA C105/A21.5 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

ANSI/AWWA C110/A21.10– American National Standard for Ductile-Iron nd Gray-Iron Fittings, 3in through 48in for Water and other liquids.

ANSI/AWWA C111/A21.11 -American National Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

ANSI/AWWA C115/A21.15- American National Standard for Flanged Ductile-Iron or Gray-Iron Threaded Flanges.

ANSI/AWWA C150/A21.50- American National Standard for Thickness Design of Ductile-Iron Pipe.

ANSI/AWWA C151/A21.51 -American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

ANSIIAWWA C153/A21.53- American National Standard for Ductile-Iron Compact Fittings, 3 inches (7.6 cm) through 24 inches ((61.0 cm), and 54 inches (137.2 cm) through 64 inches (162.6 cm) for Water Service.

AWWA C600 AWWA- Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

ANSI/AWWA C653. AWWA- Standard for Disinfecting Water Mains.

1.4 QUALITY ASSURANCE.

1.4.01 Contractor Qualifications Contractor shall have 5 years documented experience successfully installing water mains and related valves and equipment with sufficient equipment and crews to install Work without delays.

1.4.02 Tolerances. Water main installation shall be within 0.01 foot of the design elevation unless otherwise authorized in writing by the Engineer.

1.5 SUBMITTALS.

1.5.01 Drawings and Data. Submit product data on all water main pipes, fittings, valves, fire hydrants, service connections, valve wells, mechanical thrust restraints, appurtenances and accessories. Submit shop drawings and calculations for all mechanical thrust restraints, thrust clocks, and manholes, wells, and pits.

1.5.02 Certifications. For all furnished materials, the Contractor shall furnish a sworn statement that the inspection and all tests required have been made and that the results comply with the requirements of the applicable standards. All affidavits of compliance shall be certified by a registered professional Engineer.

1.6 DELIVERY, STORAGE AND HANDLING PRODUCT.

1.6.01 Delivery of Materials. Hydrants, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing hydrants shall not damage the hydrants. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes, or other abrasive tools shall not be permitted to come into contact with the polyethylene lining.

1.6.02 Handling of Materials. Load and unload hydrants using suitably approved hoist and skidding. Hydrants shall not be dropped, bumped or allowed to impact against itself. The Engineer shall reject damaged hydrants. Lifting devices shall be suited to the Work and shall protect surfaces from damage.

1.6.03 Storage of Material. Store all hydrants and accessories off the ground, drained and kept free of water to protect against damage from freezing. Hydrants and appurtenances shall be kept in their original containers until ready for installation.

All joints and sealing materials subject to ultra-violet or ozone attack and used in the water main system shall be protected from the sunlight, atmosphere and weather, stored in suitable enclosures until ready for installation.

1.5.04 Damaged Material Hydrants in which the lining has been damaged shall be replaced.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

2.1.01 WORKMANSHIP**:** All operations in the manufacture of the hydrants shall be conducted in accordance with the best modern foundry and machine shop practice. All castings shall be "Made in USA", and be sound, clean, smooth, and free from cold shuts, scales, bumps, blisters, sand holes, porous areas and other defects, which make them unfit for their intended use. No plugging, brazing or welding of defects will be allowed.

2.1.02 BRONZE: Bronze for the operating nut shall conform to the current specifications for Manganese Bronze Castings of the American Society of Testing Materials, B 584.

Bronze required in other hydrant parts shall conform to the current Standard Specifications for Composition Brass or Ounce Metal Castings of the American Society of Testing Materials, B 62-09.

2.1.03 DUCTILE IRON: The lower standpipe barrel shall be made of Class 53 Ductile Iron pipe per AWWA C151 with screwed on AWWA C151 ductile iron flanges. Ductile Iron shall conform to ASTM A536. The nozzle section and bonnet shall be made of ductile iron per ASTM 536.

2.1.04 "O" RING SEALS: The material for "O" Ring Seals shall be Buna-N. All pressure connections shall be sealed with "O" rings.

2.1.05 BOLTS AND NUTS: All bolts and nuts shall be 304 stainless steel and in conformity with the current ASTM Designation: A 320. "Alloy Steel Bolting Materials for Low Temperature Service". Bolts included in the accessories packs shall have core blue coating. The nuts shall be hexagonal in shape. Bolt heads shall be American Standard Regular, semi-finished, hexagon; nuts shall be American Standard Regular semi-finished, hexagon.

Bolt and nut threads shall conform to the current Specifications for Screw Threads for Bolts, Nuts, Machine Screws, and Threaded Parts of the American Standards Association, Specification No. B1. I, coarse thread series, Class 2 fit.

2.1.06 OPERATING NUT: The operating nut shall be a one piece design, manufactured of ASTM B-584 bronze. The operating nut shall be affixed to the bonnet by means of an ASTM B-584 bronze hold down nut. The hold down nut shall be threaded into the bonnet in such a manner as to prevent accidental disengagement during the opening cycle of the hydrant. A weather shield or seal shall be incorporated with the hold down nut, for the purpose of protecting the operating mechanism from the elements.
The operations nut shape shall be pentagon shaped with the following dimensions:

a. Taper 1/32 inches
b. Dimension across flats at top -3/4 inches, 1-1/8 inches point to flat
c. Dimension between top and bottom of pentagon nut -1-1/8 inches.

The lubrication system shall be sealed from the waterway and any external contaminants by use of "O" ring pressure seals. Anti-friction washers shall be in place above and below the thrust collar of the operating nut to further minimize operating torque. The grease reservoir shall be factory filled with an FDA approved food grade lubricant. Oil shall not be used.

2.1.07 MAIN VALVE STEM: The main valve stem shall consist of both an upper operating stem and a lower operating stem connected by a steel stem coupling. The safety coupling shall be a one-piece design. Multiple parts and cast iron not allowed. The upper stem threads shall be ACME type with no 60 deg. V threads allowed. Travel stops shall be in the inlet/shoe and are not allowed in the bonnet area. Screws, pins, bolts or fasteners used in conjunction with the stem coupling shall be stainless steel.

Material for both stems shall conform to the Specifications for Cold-Finished Carbon Steel Bars and Shafting of the American Society of Testing Materials, 1 ¼” Steel Bar Stock grade C 1045.

The coupling shall be designed to transmit the torsional strength of the shaft and fail at less than 50% of the stem material's tensile strength.

2.1.08 VALVE DISC: The valve disc shall be of either Synthetic Rubber or SBR Rubber.

Synthetic Rubber Valve Disc
Synthetic rubber valve discs shall be made of synthetic rubber and shall be reinforced with nylon fibers. The material shall be homogenous and not built up of laminated sheets. Synthetic rubber shall be in conformity with the following physical characteristics:

Shore A Durometer:	91 +/-5
Tensile Strength:	3,055 psi
Elongation:	194%

SBR rubber shall be in conformance with

Shore A Durometer:	94 +/-2
Tensile Strength:	3,055 psi
Elongation:	194%

2.1.09 VALVE OPENING: The valve-opening diameter shall not be less than 5 ¼”. The valve opening area shall be not less than 21.6 square inches.

2.1.10 NOZZLES: Hydrants shall have two brass pumper nozzles, spaced 90 degrees apart, with a 3 ¾” inside diameter and the following thread:

6-60 degree"V1'threads per inch -cut off at top 0.010 inches -left at bottom 0.010 inches -Higbee Cut at outer end of thread -O.D. 4.546 inches -R.D. 4.299 inches.

The first 3/16-inch shall have an outside diameter of 4.299 inches with no thread and a 1/32-inch x 45 degree chamfer. Nozzles shall "thread" counterclockwise into hydrant barrel utilizing "O" ring pressure seals. A suitable nozzle lock shall be in place to prevent inadvertent nozzle removal. Wedging devices and/or ductile iron retainer rings to secure nozzles shall not be allowed.

2.1.11 DIRECTION OF OPENING HYDRANT: The direction of opening the hydrant shall be left (counter-clockwise). An arrow shall be cast on the top of the hydrant to indicate the opening direction.

2.1.12 INLET CONNECTION: The inlet/shoe shall be fusion-bonded epoxy coated per ANSI/AWWA C550 and with an NSF61 approved coating having ample blocking pads for sturdy setting. A minimum of six stainless steel bolts and nuts are required to fasten the shoe to the lower barrel.

End connections shall be 6-inch Tyton joint in accordance with ANSI/AWWA C111/A21.11ANSI.

2.1.13 BREAKABLE FLANGE: The flange shall be the traffic safety flange that breaks on impact.

2.2 ACCEPTABLE MANUFACTURERS: East Jordan Iron Works model 5BR250 with Carrol drain assembly and Clow Medallion.

PART 3 – EXECUTION

3.1 INSPECTION:

Fire Hydrants shall be carefully examined for cracks and other defects immediately before installation. All defective hydrants shall be removed from the site of the work.

The DWSD reserves the right to inspect hydrant parts at any time during the process of manufacture. The Engineer of the DWSD herein referred to as the Engineer, or his authorized representative shall have access to all parts of the Manufacturer's plant where any hydrant parts are being manufactured.

Upon request of the Engineer, tension and transverse test specimens shall be made from any melt from which the castings are made, in accordance with the requirements of A.S.T.M. Specification, Designation A 126, the Manufacturer shall certify that all test specimens are made from the same metal and melt as the castings. The expense of laboratory tests shall be borne by the City.

3.2 TESTING:

Upon request, each hydrant shall be tested in the presence of the Engineer to a hydrostatic pressure of 500 psi and shall be subjected to a careful hammer test while under this pressure. Such additional tests shall be made which, in the judgment of the Engineer, are necessary to determine that the hydrants will function in the intended manner. Also upon request, supplier shall furnish flow data indicating friction loss in psi at a flow of 1,000 gpm from the pumper nozzle. Such friction loss shall not exceed 2.5 psi. Also, the DWSD may request the manufacturing "point of origin" for any/or all hydrant parts. All cast components shall be made in the USA.

3.2.1 NOTICE OF TESTING: The Engineer shall be given seven days notice in advance of the above shop tests in order that arrangements may be made for his representative to be present. The Contractor shall complete the entire order prior to notification of testing so that only one inspection trip will be required.

3.3 VALVES. All valves shall be installed to the grade, lines, levels and locations indicated on the Plans.

Valve connections shall be as specified for the piping materials used. Valves shall be set with the stem plumb on permanent, firm foundations as indicated on the Plans.

Where required, valves shall be supported with special supports as indicated on the Plans and as approved by the Engineer. Valves shall be installed so as not to receive support from the connecting pipe. In no case shall valve installation be used to bring misaligned pipe into alignment.

3.4 HYDRANTS. All hydrants shall be installed plumb to the lines, levels, grades, and locations indicated on the Plans. Hydrants shall be set to the established grade, and shall meet the following requirements:

1) Detroit Standard Hydrant Required.
2) Centerline of 4" inch opening of hydrant shall not be less than 19" inches above ground, facing curb line.
3) Hydrant shall not be installed more than 3' feet from curb line.
4) Fire hydrants shall not exceed a distance of 300' feet.
5) Hydrant shall be East Jordan Iron Works, Midwest 6BR and shall conform to AWWA specifications C502.
6) Hydrant shall be Traffic Model with breakable flange and coupling.
7) Hydrant shall have swivel flange to allow bonnet to be turned 360 for ease of facing.
8) Hydrant shall have full 6 ¼” valve opening which closes with the water pressure.
9) Inlet connection to be 6” Tyton Joint.
10) Hose Connections: 2-4” Pumper Nozzles with Detroit Standard Thread.
11) Operating nut to be 1-1/8” P-F pentagon shape, open left.
12) Color: Red No. 1210
13) Bury: 5’6”, or as specified otherwise.
14) Hydrant to be furnished with Carroll Drain.
15) No automatic drain outlet.

Where necessary to adjust for proper hydrant grade and location, the Contractor shall install additional fittings and spigot pipe between the hydrant and the water main road box.

The Contractor shall plumb all hydrants at the time they are set with the plumb line or other means acceptable. Upon substantial completion of cleanup, the Contractor shall recheck all hydrants for plumb and grade and shall make all adjustments as directed at this time. The Work of constructing fire hydrants shall not be considered complete until these final adjustments for plumb and grade have been made.

3.5 VALVES BOXES. Install valve boxes to the grade, lines, levels, and locations indicated on the Plans. Valve boxes shall not transmit shock or stress to the valve and shall be set plumb with covers centered over operating nuts and flush with the indicated surface elevations. Valve boxes that shift or fill during backfilling shall be uncovered and reset.

3.6 Tapping Valve Assembly. Install all tapping valve assemblies of sizes and to the lines, elevations, locations and indicated on the Plans. The tapping sleeve shall be assembled around the main, and the tapping performed in strict accordance with the manufacturer's recommendations. Tapping shall be accomplished without interruption of service.

3.7 FIRE HYDRANT APPROACHES:

Fire hydrant approaches shall consist of culvert pipe with end protection and a gravel approach. The culvert pipe shall be of the size and type shown on the Plans. The culvert pipe shall be installed to the existing or proposed grade of the drain with pipe bedding and backfill from a point 4 inches (10.2 cm) below the pipe to a point 12 inches (30.5 cm) above the top of the pipe, consisting of bank run sand meeting the requirements of MDOT Class II granular material and compacted to 95% of maximum unit weight. Each end of the culvert pipe shall be protected against erosion, as shown on the Plans. The gravel approach shall extend from the edge of the travel portion of the road to the fire hydrant and shall be a minimum of 10 feet (3.1 m) wide. The gravel approach shall consist of a minimum of 6 inches (15.2 cm) of compacted 22A or 23A aggregate, with calcium chloride applied at rate of 6 pounds per ton (3 kg per 1000 kg) of aggregate.

3.8 PAINTING:

All interior and exterior surfaces of lower barrel standpipes shall be thoroughly cleaned and then painted with two coats of coal tar enamel or bituminous paint as approved by the Engineer. The exposed portion of the exterior of the standpipe shall first be painted with one coat of an approved zinc chromate primer. The nozzle section, bonnet, caps, and weather shield shall be painted with TGIC epoxy powder paint system. Color shall be red.

3.9 FIELD QUALITY CONTROL:

3.9.01 Pressure Test: Refer to section 3.5.01 in specification section 02620.

3.9.02 Warranty: All hydrants shall come with a limited 10-year warranty on materials and workmanship.

End of Section

SECTION 02621

HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

PART 1 – GENERAL

1.1 SECTION DESCRIPTION. This specification governs the material, pipe, fittings, joining methods and general construction practices for High Density Polyethylene (HDPE) piping systems, 4" and smaller, for the transportation of sewage buried below grade as indicated in the Contract Documents.

1.2 REFERENCES.

AWWA C901 Polyethylene (PE) pressure Pipe & Tubing, 1/2 inch through 3 inch for water

AWWA C906 Polyethylene (PE) pressure Pipe & Fittings, 4 inch through 63 inch for water

ASTM D3035 Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter

ASTM D3261 Butt Heat Fusion PE Fittings for PE Pipe & Tubing

ASTM D3350 Standard Specification for PE Pipe & Fittings Materials

ASTM D1238 Melt Flow Index

ASTM D1505 Density of Plastics

ASTM D2837 Hydrostatic Design Basis

NSF Std.#14 Plastic Piping Components & Related Materials

TR-33/2005 Generic Butt Fusion Joining Procedure for Field Joining of PE Pipe

1.3 GENERAL.

1.3.01 Use

HDPE pipes/fittings shall be allowed for use as wastewater pressure pipe where compatible with the specific conditions of the project. The use of material other than HDPE pipe may be required if it is determined that HDPE pipe is unsuitable for the particular application.

1.3.02 Documentation

Documentation from the resin's manufacturer showing results of the following tests for resin identification:

Melt Flow Index ASTM D1238

Density ASTM D1505

1.3.03 Manufacturer

All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be: PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc., SCLAIRPIPE as manufactured by DuPont of Canada or equal as approved by the Engineer.

1.3.04 Finished Product Evaluation

Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which become part of the manufacturer's permanent records.

Pipe in process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)

Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.

Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference at both ends of the pipe to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.

Pipe length shall be measured.

Pipe marking shall be examined and checked for accuracy.

Pipe ends shall be checked to ensure they are cut square and clean.

Subject inside surface to a “reverse bend test” to ensure the pipe is free of oxidation (brittleness).

1.3.05 Stress Regression Testing

The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 800 psi.

1.3.06 Compatibility

Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

1.3.07 Warranty

The pipe MANUFACTURER shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the OWNER. The MANUFACTURER shall replace at no expense to the OWNER any defective pipe/fitting material including labor within the warranty period.

PART 2 - PRODUCTS

2.1 MATERIALS FOR PIPE SIZES 4-INCH DIAMETER AND LESS.

2.1.01 Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345464C per ASTM D3350; and meeting Type lll, Class C, Category 5 per ASTM D1248.

2.1.02 High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C906.

2.1.03 If rework compounds are required, only those generated in the Manufacturer’s own plant from resin compounds of the same class and type from the same raw material supplier shall be used.

2.1.04 Dimensions and workmanship shall be as specified by ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.

2.1.05 HDPE pipe and accessories shall be 160 psi at 73.4 meeting the requirements of Standard Dimension Ration (SDR) 11 as MINIMUM STRENGTH.

2.1.06 The pipe Manufacturer must certify compliance with the above requirements.

2.2 FITTINGS.

2.2.01 All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Engineer.

2.2.02 The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the Drawings and specified herein.

2.2.03 All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters and must be approved by the Engineer. NO size on size wet taps shall be permitted.

2.2.04 All transition from HDPE pipe to steel pipe shall be made per the approval of the Engineer and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector adapter within a carbon steel back-up ring assembly shall be used for pipe type transitions.

Transition from HDPE to steel fittings and valves shall be approved by Engineer before installation.

Fittings and transitions shall be as manufactured by Phillips DRISCOPIPE, Inc., 1000 Series Pressure Pope, Chevron chemical company Plexco/Spiralite pipe, or equal.

The pipe supplier must certify compliance with the above requirements.

2.3 PIPE IDENTIFICATION.

2.3.01 The following shall be continuously indent printed on the pipe or spaced at intervals not exceeding 5-feet:

Name and/or trademark of the pipe manufacturer.

Nominal pipe size.

Dimension ratio.

The letters PE followed by the polyethylene grade in accordance with ASTM

D1248 followed by the hydrostatic design basis in 160's of psi, e.g., PE 3408.

Manufacturing standard reference, e.g., ASTM F714 or D-3035, as required.

A production code from which the date and place of manufacture can be determined.

2.3.02 Tracing Wire

All HDPE shall have wire conforming to Copperhead Industries Reinforced #1245 Extra-High Strength Tracer Wire and affixed to the drilling head/reamer.

2.3.03 Marking Tape: Marking tape shall be installed per Engineer approval.

PART 3 - EXECUTION

3.1 JOINING METHOD.

3.1.01 The pipe shall be joined with butt, heat fusion joints as outlined in ASTM D2657 and conform to the Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe, Technical Report TR-33/2005, published by the Plastic Pipe Institute (PPI). All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Owner.
3.1.02 Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipes so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet.

3.1.03 On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the owner. The following shall apply:

Heating plate surfaces shall be inspected for cuts and scrapes and shall be free of dirt and residue. Heater surfaces should be between 400°F (minimum) to 450°F (maximum). Measure the temperature @ 12:00, 3:00, 6:00 and 9:00 o'clock positions using a pyrometer of infrared thermometer at locations where the heating plate will contact the pipe/fitting ends. The maximum temperature difference between any two points on a single heating surface must not exceed 24°F. If this temperature is exceeded, the heating plate shall be cleaned per the manufacturer's recommendations.

The fusion or test section shall be cut out after cooling completely for inspection.

The test section shall be 12" or 30 times (minimum) the wall thickness in length and 1" or 1.5 times the wall thickness in width (minimum).

The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16” to a maximum 3/16”.

3.1.04 The polyethylene flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ANSI B16.1 and shaped as necessary to suit the outside dimensions of the pipe. The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer’s specified torques. Bolts shall be tightened alternatively and evenly. After installation, apply a bitumastic coating to bolts and nuts.

3.2 INSTALLATION.

3.2.01 High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the Drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

3.2.02 HDPE shall be installed by Directional Bore Method as outlined in Section 3.2.17 –Directional Bore Installation.

3.2.03 Care shall be taken in loading, transporting and unloading to prevent damage to the pipe. Pipe or fitting shall not be dropped. All pipe or fitting shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Engineer. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.

3.2.04 Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon “pull-back”.

3.2.05 Care shall be taken during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.

3.2.06 Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.

3.2.07 Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

3.2.08 Pipe shall be stored on clean level ground to prevent undue scratching or gouging. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.

3.2.09 Pipe shall be laid to lines and grade shown on the Drawings with bedding and backfill as shown on the Drawings.

3.2.10 When laying is not in progress, including lunchtime, the open ends of the pipe shall be closed by fabricated plugs, or by other approved means.

3.2.11 Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined.

3.2.12 The pipe shall be joined by the method of thermal butt fusion, as outlined in PART 3 – Execution, Section 3.1 Joining Method. All joints shall be made in strict compliance with the manufacturer's recommendations.

3.2.13 Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:

A polyethylene flange shall be thermally butt-fused to the stub end of the pipe.

A 316 stainless steel back up ring shall mate with a 316 stainless steel flange.

316 stainless steel bolts and nuts shall be used.

3.2.14 Flange connections shall be provided with a full-face neoprene gasket.
3.2.15 All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

3.2.16 If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

3.2.17 Directional Bore Installation:

Refer to Specification 02237 - Horizontal Directional Drilling in its entirety.

3.3 CLEANING.

3.3.01 At the conclusion of the work, thoroughly clean all of the new pipe lines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period by forcing a cleaning swab through all mains 4” or greater. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the Owner. Debris cleaned from the lines shall be removed from the job site.

3.4 TESTING.

3.4.01 Pressure testing shall be conducted per Manufacturer’s recommendations and as approved by the Engineer.

3.4.02 All HDPE mains shall be field-tested. Contractor shall supply all labor, equipment, material, gages, pumps, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

3.4.03 All HDPE mains shall be tested at 150 percent of the operating design pressure of the pipe unless otherwise approved by the Engineer.

3.4.04 Pressure testing procedure shall be per Manufacturer’s recommendations or as follows:

Fill line slowly with water. Maintain flow velocity less than 2 feet per second.

Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation.

Apply initial test pressure and allow to stand without makeup pressure for two to three hours, to allow for diametric expansion or pipe stretching to stabilize.

After this equilibrium period, apply the specified test pressure and turn the pump off. The final test pressure shall be held for one to three hours.

Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Owner at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Engineer.

3.4.05 Allowable amount of makeup water for expansion during the pressure test shall conform to Chart 6, Allowance for Expansion Under Test Pressure, Technical Report TR 31/9-79, published by the Plastic Pipe Institute (PPI). If there are no visual leaks or significant pressure drops during the final test period, the installed pipe passes the test.

3.4.06 If any test of pipe laid disclosed leakage significant pressure drop greater than the manufacturer’s recommended loss, the Contractor shall, at his/her own expense, locate and repair the cause of leakage and retest the line. The amount of leakage, which will be permitted, shall be in accordance with AWWA C600 Standards.

3.4.07 All visible leaks are to be repaired regardless of the amount of leakage.
3.4.08 The Contractor must submit his plan for testing to the Engineer for review at least 10 days before starting the test and shall notify the Owner a minimum of 48 hours prior to test.

End of Section

SECTION 02626

STEEL TRANSMISSION PIPE

PART 1 – GENERAL

1.1 SCOPE. This section includes the furnishing and installation of 36 inch steel water pipe with bell and spigot O-ring gasketed joints and internal lap welded restrained joints, conforming to the requirements of the current ANSI/AWWA C200, Standard for "Steel Water Pipe 6-Inch and Larger" and AWWA M11, “A Guide for Design and Installation, except as otherwise hereinafter specified.

1.2 QUALITY ASSURANCE.

1.2.01 SPFA Certification Program. Steel pipes and fittings furnished in this Contract shall be manufactured, fabricated, lined and coated in a plant certified under Steel Plate Fabricators Association (SPFA) Quality Certification or ISO 9001. Steel pipe manufacturer shall have 5 years prior experience manufacturing large diameter pipes and fittings designed for high pressure under similar field conditions as those specified under this Contract. This program shall assure the Engineer that the steel pipe and accessories are produced by a certified fabricator committed to supplying high quality products that meet all the requirements of AWWA Specifications. All specials and fittings shall be fabricated in accordance with the manufacturer's approved shop drawings.

1.2.02 Inspection. All pipes and fittings furnished under this Contract shall be subject to inspection, in the shop, by a representative of the Detroit Water and Sewerage Department (DWSD). The Manufacturer shall notify the Engineer at least ten (10) days in advance of the date when fabrication will start, so that a DWSD representative may be assigned to witness fabrication and tests. DWSD representatives shall be personnel that have direct knowledge of the project. Not more than four (4) DWSD representatives, two (2) from the Design Group will be assigned to the pipe fabrication and a maximum of two (2) shop visits will be required for this Contract. All costs of inspection should be born by owner. We have no control over their arrangements. The DWSD representatives shall have free entry at all times to all parts of the shop where pipe is fabricated. The fabricator shall furnish all materials, tools and equipment required in making all essential tests. The DWSD representatives shall also be provided with a "hard hat", goggles and such other equipment. Such inspection shall not relieve the manufacturer of responsibility to furnish material and perform work in accordance with these Specifications. Material which arrives at the jobsite and does not conform to these Specifications shall be rejected and shall be replaced at no cost to the Owner or repaired to the owner’s satisfaction.

1.2.03 Welding Requirements. All welding shall be done by certified welders who have had adequate experience in the method and materials to be used. All welders shall be certified under the standard qualification procedure of the American Welding Society (AWS Dl.1).

1.2.04 Shop Test on Production Pipe. Each length of pipe shall be tested by the manufacturer in accordance with ANSI/AWWA C200 Standard.

1.3 REPORTS AND SUBMITTALS. The following data shall be submitted to the Engineer for approval prior to start of fabrication: Design calculation on pipe wall thickness and reinforcement, design calculation in restraining or anchoring bends, tees, dead ends, reducers or any fitting where fluid flow would produce a thrust on the pipe that tends to pull the joints apart, assembly drawings showing overall dimensions and location of each piece identified by Mark No. or a tabulated pipe laying schedule indicating location, stationing, elevation, bends including horizontal and vertical deflections, outlets and other key points along the line, all necessary shop drawings showing complete details of all pipe and fittings furnished. A pipe delivery schedule that is compatible with the Contractor's progress schedule, certified welding procedures to be used in fabrication of this material and list of qualified and experienced welders with certification for the above welding procedures.

The following data shall be submitted prior to approval of any progress payments on materials furnished under this Section: Affidavit of Compliance certifying that all pipe, specials and fittings supplied comply with all provisions of this Contract. Certified mill test reports of steel plates or sheets used in fabrication of this material. Certified mill test reports of all steel pipe, and certified records of hydrostatic tests.

1.4 PRODUCT HANDLING.

1.4.01 Prior to shipment. Pipe shall be visually inspected for damage to the coating. When visual inspection shows a portion of the polyethylene tape system has sustained physical damage, the area in question may be subjected to an electrical holiday test as detailed in AWWA C-214. Repair should only be made by a manufacturer's representative. When the area is tested and there are no holes or no tearing of the material (only wrinkling or bruising) then the area shall be noted OK and shipped with no patching required. When the damaged area does show damage to steel from either a visual inspection or from the use of a holiday detector, expose the inner wrap of black polyethylene repair tape and cut back the damaged layers leaving a smooth surface. The area shall then be wiped clean and dry with a rag and a coat of primer shall be applied to the area. When the primer is tacky, apply a patch of polyethylene tape of sufficient size to completely cover the damaged area, plus a minimum lap of 4 inches on sound tape in all directions. A second patch of polyethylene repair tape shall then be put over the first patch once again insuring a minimum overlap of 4 inches beyond the first patch on a clean dry surface. Repair tape and primer shall conform to ANSI/AWWA Standards and the tape shall be 35 mil high tack polyethylene tape compatible with the original tape system.

1.4.02 Storage and Delivery. Pipe shall be stulled as required to maintain roundness of plus or minus 1 percent during shipping and handling. All pipe and in-line fittings shall be clearly marked to correspond to the mark number on the approved laying schedule. Pipe shall be delivered, handled and stored in a careful manner to avoid damage. Pipe shall at all times be secured against sliding, rolling, falling, or any other such movement that may cause damage. Pipe shall be stored at the site in locations where it will not interfere with traffic or entrances to private property. Pipe shall not be stored on public property until permission is obtained from authorities having jurisdiction there over. Pipe shall not be stored on private property without the owner's written permission, evidence of which shall be furnished to the Engineer. In distributing the pipe in the field, each pipe shall be placed as near as possible to the point where it is to be laid and end facing in the proper direction. Coated pipe shall be stored on padded skids, sand or dirt berm, sand bags or other suitable means so that the coating will not be damaged.

1.4.03 Protection. Pipe shall be handled and transported in such a manner as to prevent damage to the pipe and its lining and coating. Padded bunks, nylon belt tied-own straps or padded banding located over stulling shall be used. No repairs shall be made to damaged pipe unless both the method of repair and the workmanship involved are inspected and approved by the Engineer. Pipe shall be transported and handled, utilizing equipment of proper capacity. Nylon or canvas slings shall be used at all times when handling steel water pipes. Pipe shall not be rolled from transport vehicle.

PART 2 – PRODUCTS

2.1 DESIGN. Steel pipe shall be designed in accordance with "AWWA M11 a Guide for Design & Installation". Design requirements for steel water pipes, except as otherwise specified or shown on the drawings are as follows:

Inside diameter of pipe after Lining (in.)	
Design pressure (psi)	100
Min. wall thickness of steel (in.)	AWWA M11 to dictate wall thickness based on performance criteria set forth by the actual project design parameters.
Design earth cover (ft.)	As shown in contract documents or minimum

	of 5 feet whichever is greater
Min. weight of backfill (pcf)	
Highway design live load	H-20
Impact Factor	1.5
E' = Modulus of soil reaction (psi)	Per Table 6-1 in AWWA M_11 Design Guide
Dl = Deflection lag factor	1

The maximum allowable design deflection for all buried pipe shall not exceed 3 percent. Pipe shall be installed to withstand flotation under all conditions. All pipe, fittings and specials shall be designed to withstand the effects of a 10-psi vacuum condition. The steel cylinder thickness of reducing sections shall be the same thickness as that required for the larger end of the reducing section.

2.1.01 Pipe Standards. Pipe shall be furnished in accordance with ANSI/AWWA C200 Standard, Section 2.1 with steel meeting the requirements of ASTM A139, Grade B, C or D; ASTM A1011; ASTM A1018 Grades 35 to 50; ASTM A53, Type E or S. Steel plate shall meet the requirements of ASTM 283, Grade C or D or ASTM A572, Grade 42. Pipes to be installed inside casing pipe or liner plate shall be designed neglecting the casing pipe or liner plate. Rimmed steel shall not be used. The weight, class and casting period of pipe shall be shown on each pipe. Changes in alignment or grade may be made by breaking the joints of the straight pipe or by use of beveled ends. Joint openings shall not exceed that recommended by the manufacturer.

2.2 ACCEPTABLE MANUFACTURERS. Pipe shall be as manufactured by American SpiralWeld Pipe, Northwest Pipe Company, or approved equal.

2.3 FITTINGS. Fittings shall be fabricated in accordance with ANSI/AWWA C200 Standard, Section 4, from pipe conforming to the above Standards. Fittings shall conform to the dimensions of ANSI/AWWA C208 Standard, "Dimensions for Fabricated Steel Water Pipe Fittings" or may be fabricated into standard or special pipe lengths. Fittings fabricated from previously hydrostatically tested straight pipe shall require testing of only those welded seams that were not previously hydrostatically tested in the straight pipe. The testing shall be dye penetrant or magnetic particle. Elbows over 0 thru 22.5 degrees shall be two-piece, over 22.5 thru 45 degrees shall be three-piece, over 45 thru 67.5 degrees shall be four-piece and over 67.5 thru 90 degrees shall be five-piece. Elbows shall have a minimum centerline radius of 2.5 x the pipe outside diameter. All tees, lateral and outlets shall be reinforced in accordance with ASME Pressure Vessel Code, Section VIII, Paragraph G-37 or AWWA M-11 Manual. Location of tees, laterals or outlets shall be a minimum of five (5) feet from the joint of any pipe.

2.4 CEMENT MORTAR LINING. Pipe shall be cement–mortar lined in the shop in accordance with ANSI/AWWA C205 Standard, “Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4 In. and Larger-Shop Applied”. The interior surface of all steel pipe, fittings and specials shall be cleaned to remove loose and foreign matter. The cement mortar lining shall be centrifugally applied as described in ANSI/AWWA C205 Standard, in the shop. Lining of all bends, reducers, fittings and specials shall be in accordance with ANSI/AWWA C205 Standard. For gasketed joint pipe, shop applied internal lining shall be continuous to the end of the pipe on the spigot end and shall be held back on the bell to the point of maximum engagement or further as shown in the joint detail. Cement–mortar lined pipe shall be stulled as required to maintain roundness during shipping and handling and shall have ends capped prior to shipment. The nominal diameter of cement mortar lined pipe shall be the inside diameter after lining. Field application of cement-mortar lining shall be in accordance with ANSI/AWWA C602 Standard, “Cement Mortar Lining of Water Pipelines-4 in. and Larger”.

2.5 TAPE COATING. Pipe shall be coated and wrapped outside with prefabricated multilayer cold applied polyethylene tape coating in accordance with ANSI/AWWA C214 Standard, "Tape Coating Systems for the Exterior of Steel Water Pipelines". The total tape coating thickness of pipe sections shall be 80 mils consisting of primer, 20 mil inner layer for corrosion protection and two 30 mil outer layers for mechanical protection. Fittings shall be coated and wrapped outside with prefabricated multilayer of cold-applied polyethylene tape coating in accordance with ANSI/AWWA C209 Standard, "Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines".

The total thickness of coating for fittings and field joints shall be 70 mils minimum consisting of primer and two wraps of 35 mil tape. Welded joints shall not be shop painted as the paint may contaminate the field weld. For gasketed joint pipe, shop applied outside coating shall be continuous to the end of the pipe on the bell end and shall be held back 4.25 inches on the spigot end. For gasketed joint pipe, the inside of bell and outside of spigot shall be shop-painted with one coat of primer compatible with the field coating materials.

2.5.01 Materials for tape coating system. The primer shall be supplied by the tape systems manufacturer and shall consist of butyl rubber matrix in a solvent which will produce an effective bond between the pipe surface to be protected and the inner wrap tape. Primer shall comply with the code and regulatory requirements regarding safety and environmental protection in effect at the location of use. Coating tapes Inner wrap shall be 20 mils thick dielectric tape having a ratio of 11 mils of pressure sensitive cross-linked butyl rubber adhesive mass bonded to 9 mils of high density polyethylene backing. The middle wrap and the outer wrap shall be colored gray or black. The second and last outer wrap shall be colored white. Minimum overlap shall be 1 inch. The overlap of successive layers shall not coincide with the overlap of the previous layer. Hand-wrapped tape for coating of fittings and field joints shall be 35 to 40 mils thick consisting of a soft cross-linked butyl rubber adhesive mass bonded to a pliable low density polyethylene backing. Shrink sleeves with a minimum thickness of 80 mils may be used in lieu of hand-wrapped tape.

2.6 LAYING LENGTHS. Pipe shall be furnished principally in 40 to 50 foot laying lengths with special lengths, field trim pieces and closure pieces as required by plan and profile for location of elbows, tees, reducers and other in-line fittings. The contractor may request approval from the Engineer if considering using shorter pipe lengths as dictated by the situation, such as machine capacity, OSHA requirements, soil conditions, etc. If 40 to 50 feet laying lengths are used, the Contractor will have to abide by MIOSHA requirements for trench. Pipe lengths for tunnel installation and where pipe is encased in concrete shall be determined by the Contractor for compatibility with construction means and methods. Prior to fabrication, approval shall be obtained from the Engineer and jurisdictional authorities. The pipe fabricator shall prepare a pipe laying schedule showing the location of each piece by Mark No. with station and invert elevation at each bell end.

2.7 GASKETED JOINTS. The standard joint for working pressures up to 250 psi shall be O-ring unless otherwise noted on the plans. O-ring joints shall conform to ANSI/AWWA C200 Standard. The O-ring joints shall consist of a flared bell end formed and sized by forcing the pipe end over a plug die or by expanding on segmented dies. The spigot end groove design to retain the O-ring rubber gasket shall be formed and sized by rolling on male-female dies to match the bell. The difference in diameter between the I.D. of bell and the O.D. of spigot shoulder at point of full engagement with allowable deflection shall be 0.00 to 0.04 inches as measured on the circumference with a diameter tape. The O-ring gasket shall have sufficient volume to approximately fill the area of the groove and shall conform to ANSI/AWWA C200 Standard. The joint shall be suitable for a safe working pressure equal to the class of pipe furnished and shall operate satisfactorily with a deflection, the tangent of which is not to exceed 0.751D where D is the outside diameter of the pipe in inches or with a pull-out of 0.75 inches.

2.8 RESTRAINED JOINTS. Pipe shall be designed to resist thrust forces developed at fittings and deflections resulting from the application of the specified hydrostatic test pressure. When angular deflection is required at restrained joints, special shop fabricated bevel pipe shall be furnished by the manufacturer to accommodate the exact angular deflection using the bevel and the accompanying joint opening. Welded joints shall be designed to resist the full thrust associated with the working and transient pressures. Restrained length shall be based on the allowable dissipation of the thrust as detailed in AWWA M11. Working stresses for design of welded joints to withstand longitudinal forces shall not exceed 50% of the specified minimum yield strength of the material for working pressure and 75% for transient conditions. Joint details proposed for welded section shall be submitted to the Engineer for approval.

2.9 FLANGES. Flanges shall be in accordance with ANSI/AWWA C207 Standard, "Steel Pipe Flanges for Waterworks Service - Size 4 In. Through 144 In.", Class D for working pressures to 175 psi on 4 thru 12 inches diameter and 150 psi on diameters over 12 inches. Flanges shall be in accordance with ANSI/AWWA C207 Standard, Class E for working pressure over 150 psi to 275 psi when mating steel-to-steel, Class F for working pressures to 300 psi (drilling matches ANSI B 16.5 Class 250). All flanges shall have a 250-500 (per C207) micro-inch finish. Shop lining and coating shall be continuous to end of pipe or back of the flange. Flange faces shall be shop coated with a soluble rust preventive compound. Blind flanges shall be equal in thickness to a ring flange of the pressure class. Blind flanges shall be machine faced to match the mating flange. Flanged outlets as detailed in the plans for blow-offs, access manholes and for installation of air and vacuum relief valves, may be utilized as needed as access for workers and material. Flanged outlet shall be capable of withstanding the specified test pressure and the manufacturer shall coordinate dimensions and drilling of flanges furnished with the flanges for valves to be installed. Flanges shall be of the slip-on or welding neck type end to be fitted with slip-on flanges shall have the longitudinal or spiral welds ground flush to accommodate the type of flanges provided.

2.10 BOLTS AND NUTS. The Contractor shall supply all flange bolts, nuts, washers and gaskets for all flanged connections to Owner furnished in-line valves. All flange bolts shall be made of the best quality open hearth or electric furnace stainless steel or zinc plated carbon steel l, having an ultimate tensile strength of at least 60,000 pounds per square inch, yield point of not less than 45,000 pounds per square inch with an elongation of not less than 18 percent in 2 inches. All nuts for flange bolts shall be hexagonal, and material shall be in conformance with the current specifications for "Carbon and Alloy Steel Nuts and Bolts for High Pressure and High Temperature Service", ASTM Specification A194, Grade 1 or ASTM A307. The flange bolts and nuts shall conform to ANSI Standard, B18.2 Heavy Series and shall have U.S.S. right-handed machine-cut threads, conforming to the requirements of ANSI Standard B1.l, "Screw Threads Coarse Thread Series", Class *2* Fit. Flange bolts shall have hot forged hexagonal heads, and the underside of the head shall be at right angles to the axis of the bolt. Bolt heads and nuts shall be hexagonal in shape and in conformance with then dimensions for "Wrench-Head Bolts and Nuts and Wrench Openings". The threads of all bolts and nuts shall be covered with an approved type of graphite coating before installation.

2.11 RUBBER GASKETS (PIPE CONNECTIONS). Rubber compound for gaskets shall conform to the requirements of the ANSI/AWWA C200 Standard.

2.12 GASKETS (FLANGED CONNECTION). Gaskets for all flanged connections shall be full-faced, single piece, 1/16 inch thick, fabricated from non-metallic, non-asbestos fiber gasket material conforming to the current ASTM Designation, F104, and shall have graphite or an approved anti-stick compound on both sides. Gaskets shall be Anchor 443-A or equal with approved anti-stick coating.

2.13 FIELD WELDS. Field welded joints shall meet the requirements of ANSI/AWWA C-206 Standard, "Field Welding of Steel Water Pipe", except as modified herein. All joints to be field welded shall be preheated in accordance with the requirements of Section 5.5, Preheating, Table 1, of ANSI/AWWA C-206 Standard. Welding procedures, materials and equipment to be used shall be submitted in writing to the Engineer for Approval prior to the work. All field welded joints in steel pipe shall be subjected to magnetic particle testing of the entire pipeline as specified. Prior to the start of the work, the contractor shall submit a list of the welders he proposes to employ, for the competency test to meet the required qualifications. All welders shall be certified for circumferential welding.

After the exterior field welded joints of steel pipe and fittings have been inspected and tested, the exterior of those joints shall received a cold applied tape or shrink sleeve coating conforming to the requirements specified herein. As an alternative to exterior welding, an internal weld may be accomplished using the weld-after-backfill method. Most restrained joints will require a single interior or exterior weld but not both. Inspection of the welds by the representative of an independent testing laboratory shall not relieve the Contractor of responsibility for the quality of all welding done or for performing the work as specified herein. All welds containing cracks or showing signs of porosity shall have the defects ground out, repaired and retested. Welded joints will only be used in restraining elbows on each side of the angle point. A distance sufficient to resist the components of thrust shall be calculated. Welded joints shall also be used to resist thrusts caused by closed valves or by changes in direction of pipeline. Welded joints shall be provided to transmit such thrusts over sufficient distance to absorb the force through skin friction provided by the backfill material against the pipe. Accurate computation of thrust and strength of the weld must be made to determine if the weld is sufficiently strong to transmit the force from one pipe section to the next. Where bell and spigot field welded joints are required on the contract drawings such as restrained joints shall provide a minimum 2.25-inch lap with a minimum of a 0.75-inch allowable pull (joint opening) for the required 1.5-inch minimum lap. Shop applied exterior coating shall be held back in accordance with the manufacturer's recommendations. The interior lining shall also be held back if so recommended by the pipe manufacturer. Lap-welded field joints shall be analyzed for proper strength close to valves and at large deflection angles. Adequate ventilation must be provided to insure adequate air exchange when crews are working inside the pipe.

2.14 CONNECTION TO OTHER PIPE MATERIAL. Care must be exercised when connecting dissimilar pipe materials, because of the possibility of galvanic corrosion. When connecting steel pipe to either gray cast or ductile iron pipe, or to concrete embedded steel cylinder pipe, or to copper or galvanized pipe, an approved electrically insulating joint shall be used. The joint insulation shall be accomplished with an insulating gasket with sleeves and washers on a flanged connection or with an insulating sleeve-type flexible coupling.

PART 3 – EXECUTION

3.1 INSPECTION. Inspect each pipe and fittings before lowering the pipe or fitting into the trench. Inspect the interior and exterior protective coating. Repair any damaged areas as previously specified. Repair of any damaged interior and or exterior protective coating shall be carried out by manufacturer's representative or Contractor's representative certified by the manufacturer. Clean ends of pipe thoroughly. Remove foreign material from inside of pipe. Keep inside clean during and after pipe laying. Handle pipe in a manner to avoid any damage to the pipe. Do not drop or roll pipe into trenches under any circumstances.

3.2 LAYING STEEL WATER PIPE. The pipeline trench shall be excavated to allow the specified thickness of selected bedding material. This material shall support the pipe over its entire length with the exception of a bell hole work area near the pipe ends. A variety of methods can be used to place joints together provided the joints and pipes are not damaged. Before the pipe is released from the slings, the entire placement of the gasket shall be checked using a feeler gage. If it is determined that the gasket has disengaged during joint engagement, the pipe shall be pulled apart and the gasket carefully checked and replaced, if necessary. The joint should then be reassembled and checked once again with the feeler gage.

Each length of pipe shall be electrically bonded to the adjacent length of pipe using two #4 copper bonding wires and termite welding cartridges furnished by pipe fabricators or clips welded to the pipe ends that can be shown to provide adequate conductivity. Backfilling operation shall commence as soon as possible to prevent movement of the installed pipe in the bedded trench. At the conclusion of each day's pipe laying, backfill shall be completed to the end of the pipe and a bulkhead installed therein.

3.2.01 Closure Pieces. Where closure pieces are required for steel pipe, the contractor shall be required to make all measurements for the same and shall be responsible for correctness of the steel sections needed to complete the work. Where steel pipe closures are cut with acetylene torches or by a similar method, the burned ends of the cut ends of the pipe shall be grounded and made smooth before completing the joint in an approved manner. Any pipe coating damaged in the cutting of the ends of closure pieces shall be repaired in accordance with ANSI/AWWA C214 Standard, "Tape Coating Systems for the Exterior of Steel Water Pipelines, or to the satisfaction of the Engineer.

3.2.02 Special Requirements. Every precaution shall be taken against flotation of the pipe. All damages from flotation shall be made good by the Contractor at his expense and to the satisfaction of the Engineer. The Contractor shall also take whatever means necessary to prevent pipe flotation where the Drawings require the pipe to be encased in concrete. If, after the pipeline has been installed, it is found that the rubber gasket is or otherwise improperly placed or that the joint is otherwise unsatisfactory, one of the adjacent pipes shall be removed and a closure pipe with new rubber gasket shall be installed. As an alternative, the joint may be welded so that it is watertight. A representative of the pipe manufacturer shall be present initially during construction activities to advise Contractor in the proper handling, storage, and installation of the pipe. The field representative shall instruct the Contractor and Owner's field personnel in the proper installation techniques and use of feeler gage and show these personnel how to accomplish a proper coating repair. The Contractor's field personnel responsible for such coating repair should be certified by the manufacturer.

3.3 HYDROSTATIC TEST. Hydrostatic field testing shall be conducted in accordance with Master Specifications Section 02670.

End of Section

SECTION 02628

PRE-STRESSED CONCRETE PRESSURE PIPE

PART 1 - GENERAL

1.1 SCOPE. This section includes the furnishing, installation and connection pre-stressed concrete cylinder pipe for pipe diameters greater than 24 inches, with rubber and steel joints. Pre-stressed concrete pressure pipe is primarily used in forced water applications, however it is not uncommon to utilize this pipe in surcharged or force-main sewer applications. Reference Master Specification Section 02620 – Water Main Services and Master Specification Section 2530 – Sanitary Sewers as appropriate.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Pipe shall be transported and handled, utilizing equipment of proper capacity.

1.2.02 Governing Standards. Except as modified or supplemented herein, all concrete pressure pipe shall conform to the applicable requirements of the following standards:

ANSI/AWWA Standards	Title
C104	ANSI Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
C207	Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
C300-97	Reinforced Concrete Pressure Pipe, Steel-Cylinder Type
C301	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
C303	Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type
C304	Standard for Design of Pre-stressed Concrete Cylinder Pipe

Concrete Pressure Pipe (M9)	Operations manual explains selection, installation, testing, and cleaning and lining practices for concrete pressure pipe.

ASTM Standards

A36	Standard Specification for Carbon Structural Steel
A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
A449 Type I	Standard Specification for Quenched and Tempered Steel Bolts and Studs
A648	Steel Wire, Hard Drawn for Pre-stressing Concrete Pipe
A663	Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties
A675, Grade 50	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
A1011, SS Grade 33	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Allow with Improved Formability
B633 Type III	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
C94	Standard Specification for Ready-Mixed Concrete
C150	Standard Specifications for Portland Cement
D2240 Method A	Standard Test Method for Rubber Property—Durometer Hardness

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Certified welders who have had adequate experience in the method and materials to be used shall do all welding. All welding operators shall be certified under the standard qualification procedure of the American Welding Society. When required by the Engineer, tests shall be conducted of the welders to determine their ability to produce welds that are in compliance with these specifications. Tests shall be made in accordance with the above named qualification procedure using machines and electrodes similar to those that are to be used on the work and in the presence of the Engineer who shall determine the quality of the work done.

Specimens shall be welded in the same position as the work for which the welder is qualifying. The Engineer may call for additional test plates as the work progresses and may demand the removal from work, under the Contract, of any welder whose work is not satisfactory, regardless of the quality of the test welds. The Contractor shall furnish all materials and bear all expenses of qualifying welders.

In lieu of tests conducted in the presence of the Engineer, the Engineer may require that the certified welders be qualified under said qualification procedure by an approved testing agency.

1.3.02 Contractors Qualifications. Contractor shall have a minimum of 5 years experience installing and connecting pre-stressed concrete cylinder pipe with rubber and steel joints.

1.3.03 Manufacturer. In order to verify that the pipes have been properly steam cured, the pipe manufacturer shall have a properly installed automatic recording device, maintained in good working order, in his curing sheds. This device shall automatically record on a chart room temperature versus time and be available to the Engineer for verification of proper curing procedures.

1.3.04 Manufacturers Field Services. The Contractor shall include in his bid, as a minimum, that the pipe manufacturer's field service representative will be on-site for the following periods:

Initial installation monitoring for a minimum period of two working days.

Provide installation advice during construction for a minimum period of five working days throughout the length of the project.

Witnessing of the pressure testing for a minimum period of one working day.

When requested, a representative of the pipe manufacturer shall be present to instruct the contractor's crew on proper installation of the first five joints and the procedure for checking pipe joints to determine whether the rubber gasket is in its proper position.

1.3.05 Testing. Complete steel plate cylinder shall be tested for water tightness by an approved method such as is specified in AWWA C301.

1.4 SUBMITTALS. Prior to pipe shipment, the Contractor shall obtain from the pipe manufacturer and submit for approval the following:

1.4.01 Affidavits of Compliance. The pipe manufacturer shall furnish an Affidavit of Compliance to the effect that all pipe and fittings supplied by the manufacturer comply with all provisions of this Contract.

1.4.02 Drawings and Data. Pipe design calculations and pertinent design information. Pipe design calculations shall include thrust restraint calculations. Pipe design calculations shall designate whether trench or embankment conditions are assumed. If trench conditions are assumed, manufacturer shall state assumed width of trench and provide an alternate bedding detail to be used during construction if design trench width is exceeded.

All necessary shop drawings showing complete details of all pipe, fittings, and specials to be furnished including but not limited to the following data for each inside pipe diameter (inches):

Design Working Pressure (psi)

Field Testing Pressure (psi)

Design Earth Cover (As shown on plans or 10 feet whichever is greater)

Minimum Weight of Backfill (Lbs./cu. ft.) (120 Lbs./cu. ft minimum)

Minimum Core Thickness (In accordance with AWWA C301) (Inches)

Mortar Coating Thickness over Wire (Inches)

Minimum Thickness for Steel Cylinder (Inches with a Zero Minus tolerance)

Minimum Wire Diameter (Inches)

Design Bedding Angle (for trench installation) (Degrees)

60 degree bedding angle may be used to design pipe for earth loads based on trench width approaching embankment conditions.

P_1 (wire Elastic Limit Pressure)

> 1.7xPw (Design Working Pressure)

A detailed drawing showing the method of securing the ends of the pre-stressing wire to the barrel of the pipe.

Commented [DJD1]: Page: 4
1st Restrained joint reference

Commented [DJD2]: Page: 4
Design Earth Cover; Depth of Backfill?

Commented [DJD3]: Page: 4
Weight of soil backfill

Commented [DJD4]: Page: 4
Design Bedding Angle

Test reports showing the physical properties of the rubber to be used in pipe joint gaskets.

Shop hydraulic test results.

Compression Test Reports, showing strength of concrete at time of wrapping.

1.4.03 Certifications. Design calculations for pipe and fittings shall be signed and sealed by a registered professional engineer licensed in the State of Michigan. This engineer shall be a current employee of the pipe manufacturer and shall have at least 5 years experience with this manufacturer.

Proof that only certified welders shall be employed on the work, furnishing to the Engineer details of the welding procedure, methods, and materials proposed to be used.

Certified mill test reports or plant test reports on each heat from which sheet steel is rolled or pre-stress wire is drawn. Test specimens cut from each shipment of cylinder steel and high tensile wire shall also be made available to the Engineer when requested prior to shipment of these materials to the pipe manufacturer.

1.4.04 Schedules. A tabulated pipe layout schedule. When beveled pipe and/or joint opening is proposed to achieve both vertical and horizontal deflection, the layout schedule shall specify the amount and direction of deflection and rotation required for each occurrence.

The pipe layout schedule shall indicate the trench width, height of cover and design pressure used in the design calculations. An alternate bedding detail, to be used during installation if design trench width is exceeded, shall be made available.

A pipe delivery schedule that is compatible with the Contractor's progress schedule.

1.5 DELIVERY, STORAGE AND HANDLING. Pipe shall be delivered and stored in a careful manner to avoid damage thereto. Pipe shall at all times be secured against sliding, rolling, falling, or any other such movement that may cause damage.

Pipe shall be stored at the site in locations where it will not interfere with traffic, sight distances or entrances to private property. Pipe shall not be stored on public property until permission is obtained from authorities having jurisdiction there over. Pipe shall not be stored on private property without the owner's written permission, evidence of which shall be furnished to the Engineer.

Pipe shall be handled and transported in such a manner as to prevent damage to the pipe and its coating. Any damaged pipe will be rejected and shall be removed from the site at once. Removal of the rejected pipe and its replacement shall be at the Contractor's expense.

No repairs shall be made to damaged pipe unless both the method of repair and the workmanship involved are approved by the Engineer and the pipe manufacturer's field service representative.

Steel cable slings for handling pipe shall have an approved covering to prevent damage to pipe.

Pipe shall not be rolled from transport vehicles.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN.

2.1.01 Dimensions. Design requirements for pre-stressed concrete pressure pipe should be provided on shop drawings. Refer to paragraph 1.4.02 Drawings and Data, for design data requirements.

Pipe of special lengths, or other approved means of adjusting length of line as laid, shall be provided to the end that each element of the water main shall be placed at the location shown on the drawings.

Unless otherwise shown on the Contract Drawings or otherwise approved, closures shall be the follower ring type. Details of closure sections shall be furnished for approval. Such number of approved closure sections shall be provided as may be required in the course of the work, subject to approval.

JOINT OPENING	SIZE
One Inch	16-Inch through 48-Inch diameter pipe
One & One-half Inches	54-Inch through 72-Inch diameter pipe
Two Inches	78-Inch through 120-Inch diameter pipe

However, the maximum allowable joint opening for installing non- restrained joint pipe in the trench shall be one-half of the above values pipe manufacturer's limit for maintaining a water tight seal. The maximum joint opening to be used on the pipe layout schedule for non-restrained joint pipe shall be 1/4-inch less than the maximum allowed for installing pipe.

Commented [DJD5]: Page: 6
Follower Ring

Commented [DJD6]: Page: 6
Joint Opening

2.1.02 Structural Design. Embedded Cylinder Pipe (ECP) and Lined Cylinder Pipe (LCP) are acceptable design alternatives for the Design Engineer for pipe diameters greater than 24 inches.

Commented [DJD7]: Page: 7
LCP

Maximum Allowable Gross Wrapping Stresses:

Diameter	Class II Wire	Class III Wire
0.192-Inch	166,500 psi	189,000 psi
1/4-Inch	158,200 psi	180,000 psi
5/16-Inch	150,000 psi	165,750 psi

The gross wrapping stress shall not exceed 75 percent of the specified minimum tensile strength of the wire, as required by ASTM Designation A648, Standard Specification for "Steel Wire, Hard Drawn for Prestressing Concrete Pipe."

2.1.03 Outlets. Outlets should be located in the center of the pipe section. The reinforcement wire shall be either wrapped continuously from one side of the opening to the other, avoiding the opening and not cutting the wire, or the wire shall be securely fastened on each side of the outlet by mechanical or other approved means.

Commented [DJD8]: Page: 7
Outlets

2.2 ACCEPTABLE MANUFACTURERS. Pipe shall be made by a manufacturer experienced in producing pipe of the type, size and quality specified herein. The pipe manufacturer shall have produced pipe for at least five years and shall have a successful performance record in the U.S.A on projects of considerable magnitude.

The concrete pressure pipe shall be manufactured by Price Brothers Co., Ameron, Hanson, Vianini or an approved equal meeting the requirements specified herein.

2.3 MATERIALS.

2.3.01 PIPE MATERIALS. Use materials meeting the requirements of ANSI/AWWA C 301 as modified herein.

Cement for concrete core and mortar coating shall conform to the requirements of "Standard Specifications for Portland Cement, " ASTM C150, Type I.

No fly ash or pozzolanic material shall be used in the concrete.

Mix water used for concrete and cement-mortar shall be fresh, clean water meeting the requirements of ASTM C94. Water used for curing pipe shall be fresh, clean water or recycled process water. Water for both uses shall be free from oil, acid, strong alkalis, salts, and vegetable matter.

Sheet steel for cylinders shall meet the requirements of the current specifications for "Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability," ASTM A1011, SS Grade 33.

Wire for circumferential reinforcement shall be as designated in ANSI/AWWA Standard C301.

Steel for joint rings shall meet the requirements of the current Standard ANSI/AWWA C301, except that ASTM A283 and ASTM A1011 steel shall be Grade 33. ASTM A663 and ASTM 675 Grade 50 steel may be used provided the minimum yield stress is 30,000 psi. Joint ring steel other than noted above shall not be used without written prior approval.

No rebound material shall be used in the mortar coating.

2.3.02 SPECIAL PIPE AND FITTINGS. Special pipe and fittings required for bends, tees, reducers, adapters (connections to line valves, etc.) and closures shall be furnished as shown on the Drawings, or as required for complete construction. The details of design shall conform to Section 4, "Fittings and Special Pipe" of ANSI/AWWA C 301 and to Chapter 8 of AWWA M9, except as otherwise specified hereinafter.

Fittings shall be composed of cut and welded steel plate or sheet with concrete or mortar coating on the interior and exterior unless otherwise shown on the drawings or approved.

Fittings shall be strutted until installed unless otherwise reinforced.

The dimensions shown on the drawings are in accordance with available information. Longitudinal pipe dimensions (lay lengths) are subject to change to meet equipment manufacturer's requirements.

Steel plate shall be of an approved thickness determined by the design pressure plus 40 percent surge pressure allowance and by the earth cover as shown on the drawings, using a 10-foot minimum plus equivalent AASHTO H-20 truck live load. Steel plate thickness, based on dead load plus live load shall be such that the predicted vertical deflection of the pipe, as calculated in Chapter 8 of AWWA M9, shall not exceed 2 percent of the inside diameter of the steel plate.

The deflection angle of adjacent sections of steel plate cylinder used for bends shall not exceed 22 1/2 degrees.

Commented [DJD9]: Page: 9
Maximum Miter on Elbow

Inside diameter of cylinder segments in bends shall be sufficient to permit shaping the lining so as to eliminate abrupt deflections in the inner surface of the bend, without reducing the thickness of lining at any point to less than 1 inch (with tolerance of 1/8 inch), and without reducing the inside diameter of the bend to less than that specified for the pipe.

The welds of each complete steel plate fitting shall be tested for water tightness by an approved method prior to mortar lining and coating application.

Steel plate fittings shall be lined and coated with mortar deposited at least 1-inch thick on the surface by an approved method unless otherwise shown on the drawings. Steel plate for fittings and specials shall conform to ASTM A36 or ASTM A283 Grade D.

2.3.03 JOINT RINGS. The steel joint rings with rubber gasket seal for non-restrained joints shall be able to withstand, without leakage, a joint opening of the amount listed in paragraph 2.2.02 Dimensions.

For joint rings on finished 54 inch and larger pipe, the out-of-roundness of either the inside bell ring or outside spigot ring contact surface, measured as the difference between maximum and minimum diameters, shall not exceed 0.5 percent of the nominal diameter of the contact surface or 1/2" whichever is less. For pipe 48 inch and smaller, the joint ring out-of-roundness shall not exceed 0.7 percent of the nominal diameter or 3/16" inch whichever is larger. Flat spots or other irregularities in joint rings shall not deviate from a 3-foot template cut to the nominal diameter of the contact surface by more than 1/8 inch.

The portions of the joint rings that will be exposed on finished pipe and fittings shall be protected from corrosion by an approved metallic coating with a minimum thickness of 0.004 inch, applied by an approved method. The exposed portions of the joint rings may be topcoated with a bitumastic paint meeting the requirements of AWWA C104.

Commented [DJD10]: Page: 9
Paint on Joint Rings

2.3.04 RUBBER GASKETS. Where an 0-ring rubber gasket is required between mating flanges, the finishes shall be as specified in Paragraph 2.9.03 Edge Grinding.

Rubber compound for gaskets shall conform to the requirements of the current ANSI/AWWA Standard C301 except for the following:

Rubber compound shall contain not less than 50 percent, by volume, of virgin natural or synthetic polyisoprene elastomer and the remainder suitable pulverized fillers. The fillers shall be free from any substance likely to have a deleterious affect on the compound. The compound shall contain no elastomer substitute of any kind, rubber that has previously been used, or reclaimed rubber.

Tensile strength of the rubber shall be at least 3000 psi.

Elongation at rupture shall be at least 425 percent.

Specific gravity shall be consistent within plus or minus 0.05 and within the range of 1.02 and 1.19.

Percentage of cold flow shall not exceed 18 percent.

Hardness of the rubber compound shall be 60 with a tolerance of plus or minus 5 as determined with a Shore A durometer, in accordance with ASTM 2240 Method A.

2.3.05 FLANGES. Pipe flange class shall be selected to suite application. Pipe flange steel meeting all requirements of current ANSI/AWWA Standard for "Steel Pipe Flanges" C-207, except where noted otherwise on drawings.

All flanges shall be in accordance with details shown on the drawings.

All flanges shall be rolled or forged steel, in accordance with details shown on the drawings, and shall conform to the requirements of the AWWA Standard C207.

2.3.06 GASKETS FOR FLANGES. Gaskets for flanged connections shall be ring type, 1/8 inch thick, nylon reinforced neoprene in compliance with AWWA C207. Gasket hardness shall be in the range of 75-85 as measured in accordance with ASTM D2240, Method A. Flange gaskets shall be in conformity with sample material approval by the Engineer.

If the Contract Drawings require 0-ring type gasket connections for flanges, they shall conform to the following: 0-ring gaskets for flanged connections shall be made of extruded neoprene rubber having a hardness of 60-70 measured with a Shore, Type A durometer and a cross sectional diameter of 0.275 inches, +0.012, -0.006 inches. The gaskets shall be shop spliced and vulcanized endless to the correct diameter to ensure leak-tight joints.

2.3.07 BOLTS AND NUTS FOR FLANGE JOINTS. The Contractor shall supply all flanged bolts, nuts, washers and gaskets for all flanged connections, including connections to City-furnished valves.

All flange bolts shall conform to ASTM A449 Type 1, with an electrodeposited zinc coating of 0.00015 inch minimum thickness in accordance with ASTM B633 Type III.

All nuts for flange bolts shall be hexagonal, and material shall be in conformance with the current specifications for "Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Both, ASTM Specification: A194, Grade ~~1~~ 2H with an electrodeposited zinc coating of 0.00015 inch minimum thickness in accordance with ASTM B633 Type III.

Flange bolts and nuts shall have American National right-handed machine-cut threads, conforming to the requirements of Flange bolts shall have hot forged hexagonal heads, and the underside of the head shall be at right angles to the axis of the bolt. Bolt heads and nuts shall be hexagonal in shape and in conformance with the dimensions for "Wrench-Head Bolts and Nuts and Wrench Openings," ANSI Standard, B18.2. Bolt heads and nuts shall be standard hex dimensions for bolt diameters 1 1/2 inch or smaller and heavy hex for bolt diameters larger than 1 1/2 inch. The threads of all bolts and nuts shall be covered with an approved type of graphite coating before installation.

2.3.08 JOINT LUBRICANT. Joint lubricant for coating the rubber gaskets and the pipe joint rings shall be furnished by the pipe manufacturer, shall meet NSF61 standards, and shall be subject to approval by the Engineer.

2.3.09 JOINT FILLING. Mortar for filling joints shall be Portland cement mortar, mixed in the proportion of 1 part cement to 2 parts sand.

2.3.010 PROTECTIVE COATING. Bitumastic coating complying with AWWA C104.

2.3.011 THRUST RESTRAINTS. Thrust restraint details are to be shown on the contract drawings. Thrust restraint is to be provided by reinforced encasement or thrust block. When limited by space or schedule, thrust restraint by method of restrained joints is an acceptable design alternative. When used, restrained joints must be at all fittings where an unbalanced thrust force will exist in the pressurized line, including elbows, tees, and bulkheads. Restrained distances and steel cylinder thickness requirements to transmit thrust forces shall be calculated by the methods and equations in AWWA M9. Calculations must be submitted as noted in paragraph 1.4.02 Drawings and Data. Restrained joints shall be of the snap ring or harness clamp mechanically restrained type. Evidence of the proposed mechanically restrained joint's strength capability, such as previous or current tests, shall be submitted to the Engineer for approval.

Commented [DJD11]: Page: 11
2nd Restrained Joint reference

2.4 MANUFACTURE AND FABRICATION.

2.4.01 General. All specials and fittings shall be fabricated only according to approved manufacturer's shop drawings.

The City will have the option to inspect pipe fabrication.

Admixtures shall not be used in the concrete pipe core or cement mortar lining or coating without written approval.

Design using multiple layers of circumferential reinforcement wire must comply with AWWA C301 and AWWA C304.

Commented [DJD12]: Page: 12
Double Wrap

Any pipe or fittings supplied from the manufacturer's inventory must comply with this specification unless written permission is granted by the Engineer.

Place concrete in the cores only by methods specified in AWWA C301.

Generally, standard pipe sections shall have a minimum laying length of 20 feet; however, under special circumstances and when approved, the minimum laying length of standard pipe sections may be reduced to 16 feet.

Out-of-roundness, dimensional tolerances and coating tolerances shall be in accordance with the latest ANSI/AWWA C301 Standard, unless otherwise stated in this specification.

2.4.02 Edge Grinding. All flanges shall have a 125 micro-inch machined finish. Flange faces shall be machine finished after flanges have been welded to the pipe in order to provide true faces perpendicular to the axis of the pipe. The machined surfaces shall be finished to a degree of smoothness, which shall not exceed the RMS micro-inch value specified.

If an 0-ring rubber gasket is required between mating flanges, the flange containing the 0-ring groove shall have a 125 RMS micro-inch finish except that all sides of the groove shall have a 63 RMS micro-inch finish. The flange mating with the flange containing the 0-ring groove shall have a 63 RMS micro-inch finished face.

Commented [DJD13]: Page: 12
Special Machine Finish

2.4.03 Shop Painting. After fabrication, each piece of pipe, fitting and special shall be clearly marked by the pipe manufacturer to indicate its design pressure, date the concrete core was poured, date of pre-stressing, design depth of cover and name of manufacturer.

Commented [DJD14]: Page: 13
Stamping and Shop Painting

Specials, fittings, and beveled pipes shall be marked to show proper locations in the pipeline.

All marks on pipe sections, fittings, and specials shall correspond to those shown on the approved layout schedule.

PART 3 - Execution

3.1 INSPECTION. Examine the areas and conditions under which work is to be performed. Correct the conditions that are detrimental to the timely and proper completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

Carefully examine each pipe, prior to placing. Promptly set aside all defective pipe and all damaged pipe. Clearly identify all defects. Do not install defective pipe or damaged pipe. Pipe shall be laid in accordance with the printed instructions of the manufacturer and as specified herein.

3.2 PREPARATION.

3.2.01 Placement. Provide excavating, trenching, and bedding in accordance with the provisions of Master Specification Section 02221, Trenching, Backfilling and Compacting and as specified herein.

Pipe shall be laid on a properly prepared subgrade by entering the spigot ring into the bell of the preceding pipe after proper alignment of the pipe.

Each gasket shall be tested or inspected. For non-testable joints, after the spigot is well entered into the bell ring so that the gasket is fully compressed and brought to its final shape, and before the next pipe is brought fully home, each gasket shall be carefully checked to ensure that it is in the proper position around the full circumference of the pipe. Stops shall be used to prevent the pipe from going home before the gasket is checked. After the gasket is checked, the pipe shall be brought fully home. For testable joints the pipe may be brought home prior to testing the joint. After the joint has been tested and the pipe is brought fully home, the pipe shall be checked for line and grade. Any misalignment shall be corrected by bringing the bell end of the pipe into its proper position. If the subgrade is too low, it shall be brought to the proper grade with a stabilized mixture of sand and cement, consisting of not over 20 parts of sand per part of cement.

Joint opening must be less than distance specified in paragraph 2.2.01 Dimensions of this specification.

3.2.02 Application of Lubricant. Before laying pipe, the bell and spigot rings shall be thoroughly cleaned. The spigot ring shall be coated with the approved lubricant after which the rubber gasket, coated with the lubricant, shall be properly placed in the spigot ring groove and the stretch equalized in the manner recommended by the pipe manufacturer. The bell ring of the preceding pipe shall also be coated with this lubricant before the pipe is guided into place.

Do not lubricate self-lubricating joints.

3.2.03 Gaskets. Installation of the "0" ring gasket shall be as directed by the manufacturer; however, no material shall be placed in the groove that will impede the movement of the gasket after the flanged connection is made.

3.2.04 Joint Filling. The annular spaces between pipe ends, both inside and outside, shall be completely filled with Portland Cement mortar mixed in the proportion of 1 part cement to 2 parts sand; however, the inside of the joints on all pipe 24 inches in diameter and smaller shall not be filled. Prior to backfilling, the outside pipe joint shall be filled with mortar. To ensure complete filling of this joint, the mortar shall be behind poured inside the diaper supplied by the pipe manufacturer, down one side of the pipe until it can be seen rising up on the opposite side, then it shall be filled from either side. The material for and the dimensions of the diaper used for retaining the mortar at the exterior joint shall be subject to approval. The diaper shall encompass the full circumference of the joint.

Mortaring of the inside joint space shall not be done until after backfilling over the joint is complete.

3.2.05 Cold Weather Requirements. In cold weather, precautions shall be taken to prevent the mortar used for filling pipe joints from freezing. Joint rings shall be heated by approved methods and the temperature of the mortar shall not be less than 60°F or more than 120°F when deposited in the joint. Immediately after placing, mortar shall be protected from freezing by placing a minimum thickness of 12 inches of sand around the joint. No pipe shall be laid and no exterior joints shall be poured when the temperature is less than 15°F unless otherwise approved.

3.2.06 Backfilling. Backfilling shall follow closely behind pipe laying unless otherwise permitted. Backfilling shall be completed up to the horizontal diameter of the pipe not more than 2 pipe lengths behind pipe laying and shall be completed to the top of the trench not more than 5 pipe lengths behind pipe laying. Backfilling shall conform to the requirements of the Master Specification Section 02221, Trenching, Backfilling, and Compacting, At the conclusion of each day's pipe laying, backfill shall be completed to the end of the pipe and a bulkhead installed therein.

3.2.07 Curves. Long radius curves, either horizontal or vertical, may be made with standard straight pipe by deflection at each joint provided that the maximum joint opening caused by such deflection shall not exceed that specified herein for pipe laying, or they may be made with straight pipe in which the spigot joint rings are manufactured on a bevel.

3.2.08 Protection. Every precaution shall be taken against flotation of the pipe. All damages from flotation shall be made good by the Contractor at his expense and to the satisfaction of the Engineer. The Contractor is especially cautioned to take whatever means necessary to prevent pipe flotation where the Drawings require the pipe to be concrete encased.

Where the Contract Drawings call for a protective coating to be applied to the exterior wall of the pipe, there shall be applied, as shown on the Drawings, either one or two coats of the coating specified in paragraph 2.3.010 Protective Coating of this specification. The method of application shall be as recommended by the coating manufacturer and as approved by the Engineer. The cost of this coating shall be included in the Contract Price.

If during pipe installation, the Engineer determines that ground conditions warrant the use of a protective coating on the pipe where the Contract Drawings do not call for a protective coating, the Contractor shall make all the necessary arrangements to furnish the pipe with the necessary protection, as specified in this specification.

Caution shall be exercised when handling, delivering, and installing this pipe so that the protective coating is not damaged. Any pipe so damaged shall be replaced or repaired by the Contractor, as directed by the Engineer, at no additional cost to the City.

3.3 FIELD QUALITY CONTROL.

3.3.01 Inspection. The pipe manufacturer shall provide a qualified field service representative, who shall be available to be on the project site within 24 hours notice from the Contractor or the Owner's representative.

The field service representative must have a minimum of 5 years experience as a representative of the pipe manufacturer in the area of providing such services. The individual may be a registered professional engineer possessing a minimum of 2 years experience in the area of manufacture of pipe, sales and service representation in lieu of 5 years of experience as stated above.

The owner's engineer shall have the right of final acceptance of the field service representative based on a resume of the individual indicating the minimum experience required above.

Pipe manufacturer must agree to supply field service assistance to the owner for the next five years at no charge on technical-field support of this pipeline.

If, after the pipeline has been installed, it is found that, at any joint, the rubber gasket is pinched or otherwise improperly placed or that the joint is otherwise unsatisfactory the joint shall be repaired in a manner recommended by the pipe manufacturer and approved by the Engineer. This may involve field welding the leaking joint or removal of one of the adjacent pipes to install shall be removed, and a closure section of pipe with new rubber gaskets.

End of Section

SECTION 02630

STORM DRAINAGE AND PIPE CULVERTS

PART 1 - GENERAL

1.1 SCOPE. Section includes storm drainage pipe, pipe culverts, fittings and accessories, catch basins, manholes, bedding and backfill and all connections to catch basins and manholes. It provides foundation drainage system work for pre-stressed concrete reservoir.

1.2 GENERAL.

1.2.01 Coordination. Coordinate the Work with trenching, paving, and other construction activities in the site.

1.2.02 Governing Standards.

ASTM C76 – Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

ASTM C443 – Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

MDOT Standard Specifications for Construction.

ASTM C478-97 Standard Specification for Precast Reinforced Concrete Manhole Sections.

Divisions 1 and 2 of the Standard Specifications for Paving and Related Construction of the City of Detroit Department of Public Works – City Engineering Division

ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

ASTM D 2729 – Specification for Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.

ASTM D 3776 – Test Methods for Mass Per Unit Area of Woven Fabric.

ASTM D 4491 – Test Methods for Water Permeability of Geotextiles by Permittivity.

ASTM D 4533 – Test Method for Trapezoid Tearing Strength of Geotextiles.

ASTM D 4632 – Test Method for Breaking Load and Elongation of Geotextiles.

ASTM D 4751 – Test Method for Determining the Apparent Opening Size of a Geotextile.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit product date for pipe, pipe joints, and accessories. Submit Manufacturer's Installation instructions and special procedures required to install products. Submit Shop Drawings for all precast pipes, manholes and catch basins.

1.3.02 Certifications. Submit Manufacturer's certificate to certify that products meet or exceed specified requirements. Submit 2 copies of the certificates to the Engineer.

Submit Certification, signed by the Contractor and foundation drainage system Installer that installed materials, indicating conformance to the specified requirements and that the system was successfully checked and tested prior to covering with filtering and drainage fill.

1.3.03 Record Drawings. Accurately record actual locations of pipe runs, connections, catch basins, inlets, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.4 DELIVERY, STORAGE AND HANDLING. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast manholes and drainage structures. Store precast concrete manholes and drainage structures to prevent damage to the Owner's property or other public or private property. Any property so damaged shall be repaired at the Contractor's expense. Clearly mark each precast structure by indentation or waterproof paint to indicate the date of manufacture, manufacturer and identifying symbols and/or numbers shown on the Contract Drawings to indicate its intended use.

Cold Weather Requirements shall comply with ACI 530.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Sewer Pipe Materials. Reinforced concrete pipe shall be ASTM C76, with Wall Type C, bell, and spigot end joints. The joint shall be ASTM C443, rubber compression gasket joint.

2.1.02 Pipe Culvert Materials. Reinforced concrete pipe shall be ASTM C76, with wall type C, bell and spigot end joints. The joint shall be ASTM C443, rubber compression gasket joint.

2.1.03 Manholes. Manhole sections shall be reinforced precast in accordance with ASTM C478 with rubber gaskets in accordance with ASTM C443. Cones shall be eccentric. Frame and Cover shall be cast iron construction, EJIW 1000C cover and 1010Z frame bolted down cover as per standard detail.

2.1.04 Drainage Pipe and Fittings. Furnish drainage pipe complete with bends, reducers, adapters, couplings, collars, cleanouts and joint materials. Use polyvinyl chloride pipe for run-off pipe to the storm drainage system, conforming to ASTM D2729, and perforated polyvinyl chloride pipe, conforming to ASTM D2729.

2.1.05 Subsurface Drainage Materials. Provide perfabricated in-place wall drainage matting conforming to ASTM D3776, ASTM D4636, ASTM D4533, ASTM D4833, ASTM D4751 and ASTM D4491, as part of the overall foundation drainage system.

For drainage core, provide the manufacturer's standard open three-dimensional, nonbiodegradable, plastic Geomatrix material designed to effectively conduct water to the foundation drainage system under maximum soil pressures.

Provide a minimum vertical flow rate of 5 gpm per foot width at 3,600 psf, and provide the manufacturers standard nonwoven geotextile fabric of polypropylene or polyester fibers, or a combination thereof.

2.1.06 Soil Materials.

Impervious Fill: Use clayey gravel and sand mixture compacted to percent of procter meeting the requirements of ASTM D1557.

Gravel Fill: Use evenly graded mixture of natural or crushed gravel or crushed stone, and natural sand with 100 percent passing a ½ inch (1.3 cm) sieve and 0 to 5 percent passing a No. 50 sieve.

Filtering Material: Use an evenly graded mixture of natural or crushed gravel or crushed stone, and natural sand, with 100 percent passing a 1 ½ inch sieve and 0 to 5 percent passing a No. 50 sieve.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that trench cut and excavation base are ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.2 PREPARATION. Hand trim excavations to required elevations. Correct over excavation with sand. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 INSTALLATION.

3.3.01 Pipe Installation. Installation shall be in accordance with Master Specification Section 02211, Excavation, Filling and Grading. Lay pipe true to the lines and grade given, bells or grooves, upgrade, ends fully and closely joined, and each section shall have a full, firm bearing throughout its length. Sewer sections showing signs of settlement or poor alignment shall, as directed by the Engineers, taken up and relaid at the Contractor's expense.

Existing live sewers and service leads shall be maintained and carefully protected during the construction of the sewers. Damaged sewer or services leads shall be immediately replaced or replaced as directed by the Engineer. When tapping an existing pipe or structure a minimum opening of the entering pipe outside diameter plus 6 inches (15.2 cm) shall be cut into the receiving structure. A minimum of 3 inches (7.6 cm) mortar layer shall be packed completely around the entering pipe. The entering pipe shall be cut with flush to conform to inner wall of pipe or structure. The entering pipe shall be incased on the outside portion of the connection to provide efficient clearing under the pipe. Damages to existing pipe or structure caused by the contractor during the topping operations shall be required or replaced at the contractor's expense.

3.3.02 Precast Concrete Manhole Installation. Do not displace or damage pipe when compacting. To ensure safety, lift precast structures at the lifting points designated by the manufacturer. Set precast structures so that they firmly and fully bear on crushed stone bedding, compacted as specified accordance on other support system shown on the Contract Drawings. Assemble multi-section structures by lowering each section into the excavation. Lower, set level, and firmly position the base section before placing additional sections.

When lowering manholes and drainage structures into the excavations and joining pipe to the units, take precautions to ensure that the interior of the pipeline and structure remains clean. Ensure joint integrity by removing all foreign materials from joint surfaces and verifying that sealing materials are placed properly. Avoid misalignment by using guide devices affixed to the lower section. Joint sealing materials may be installed at the site or at the manufacturer's plant.

Verify that manholes and drainage structures installed satisfy required alignment and grade. Cut pipe to finish flush with interior of structure. Remove knockouts or cut structure to receive piping so as not to create openings more than that required to receive pipe. Fill annular space with mortar. Shape inverts through manhole as shown on the Contract Drawings.

3.3.03 Foundation Drainage Installation. Install all foundation drainage equipment in accordance with the manufacturer's recommendations and approved shop drawings and as specified in Master Specifications Division 1. Foundation drainage system must be checked and tested prior to covering with filtering and drainage fill

Impervious Fill at Footings: After concrete footings have been cured and forms removed, place impervious fill material on the subgrade adjacent to the bottom of footings. Place and compact impervious fill to the dimensions indicated or, it not indicated, not less than 6 inches (12.2 cm) deep and 12 inches (30.5 cm) wide.

Filtering Material: Place a supporting layer of filtering material over the compacted subgrade where drainage pipe is to be laid, to the depth indicated or, if not indicated, to a compacted depth of not less than 4 inches (10.2 cm).

Laying Drain Pipe: Lay the drain pipe solidly bedded in the filtering material. Provide full bearing for each pipe section throughout its length, to true grades and alignment, and with a continuous slope in direction of flow. Provide collars and couplings as required, Provide recesses in excavation bottoms to receive bells for drain pipe having bell and spigot ends. Lay the pipe with bells facing up slope with spigot and entered fully into the adjacent bell. Seal joints.

Gravel Fill: Place gravel fill over drain lines, after satisfactory testing and covering of drain lines with filtering material. Completely cover drain lines to a width of at least 24 inches (61 cm) on each side and above the top of the pipe. Place fill material in lifts not exceeding 3 inches (7.6 cm) in loose depth and compact each lift as it is placed. Wrap gravel fill material with one layer of synthetic nonwoven drainage fabric (equivalent opening size 70-100), overlapping the edges by at least 4 inches (10.2 cm).

Connect continuous foundation drainage systems to the storm drainage system.

Test or check lines before backfilling to confirm free flow. Remove obstructions, replace damaged components, and retest the system until satisfactory. After testing drain lines, place additional filtering material to a 4 inch (10.2 cm) depth around the sides and top of drains. Coordinate the placement of drainage mats with other foundation drainage materials. Do not use drainage mat as protection board for waterproof membrane unless otherwise approved by the membrane manufacturer. Use adhesives and mechanical fasteners as recommended by the matting manufacturer. Lap edges of fabric and extend the fabric around the foundation drainage pipe in accordance with the mat manufacturer's recommendations. Protect in-place matting during backfill operations in accordance with the matting manufacturer's instruction

Backfill to Grade. Place backfill material over the compacted gravel fill at footing drains, placing material in lifts not exceeding 6 inches (15.2 cm) in loose depth and thoroughly compacting each lift. Carry backfilling to the indicated finish elevations sloping it away from the building perimeter.

3.4 FIELD QUALITY CONTROL. Request inspection prior to placing aggregate cover over pipe. Where required, adjust the top elevation of existing manholes and drainage structures to suit finished grades shown on the Contract Drawing.

Reset existing frames, grates and covers, carefully removed, cleaned of all mortar fragments, to the required elevation in accordance with the requirements specified for installation of castings. Remove the concrete so as not to damage the existing vertical reinforcing bars when removal of an existing concrete wall is required. The vertical bars shall be cleaned of all concrete and bent into the new concrete top slab or spliced to required vertical reinforcement, as shown on the Contract Drawings.

3.5 MAINTENANCE.

3.5.01 Protection. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations. Where pipe is damaged or displaced, take remedial measures as directed by the Engineer, including but not limited to, retesting of joints, relaying pipe or replacing pipe. Provide remedial measures at no additional cost to the Owner.

End of Section

SECTION 02675

DISINFECTION OF WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SCOPE. This section covers the cleaning and disinfection of new water pipelines and associated appurtenances. Pressure and leakage testing shall be completed before cleaning and disinfection of new water pipes is started.

1.2 GENERAL. The Contractor shall provide the necessary apparatus for making chlorine residual tests by the drop dilution method as set forth in Appendix A of America Waterworks Association (AWWA) C651. Chlorine residual tests will be performed by the Contractor.

The Owner will perform bacteriological tests on the water lines after the disinfection is completed. Should the bacteriological tests indicate the presence of coliform organisms at any sampling point, the pipe shall be reflushed, resampled, and retested. If check samples show the presence of coliform organisms, then the main shall be rechlorinated until results acceptable to the Engineer are obtained. The Contractor shall be available to assist the Owner as required.

1.2.01 Coordination. The Contractor shall coordinate flushing work with adjacent work as necessary to preclude work interference or duplication of effort and to expedite the overall progress of the work. Water required for flushing, cleaning and disinfection work will be provided by the Owner.

1.2.02 Governing Standards**.** All disinfection work shall conform to the requirements of ANSI/AWWA C651. All disinfection work shall conform to the requirements of the Michigan Department of Environmental Quality. If any State requirements conflict with the provision of this Section, the State requirements shall govern. All Specifications are to be the Current Edition

AWWA (American Water Works Association), B300 – Standard for Hypochlorites.

AWWA B301 – Standard for Liquid Chlorine.

AWWA C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances.

AWWA C651 – Standards for Disinfecting Water Mains.

1.3 QUALITY ASSURANCE. Perform Work in accordance with AWWA C651. All Specifications are to be the Current Edition

1.3.01 Contractor Qualifications. Contractor shall be a water treatment firm specializing in disinfecting potable water systems specified in this section with a minimum of 5 years documented experience.

The testing firm shall be a company specializing in testing potable water systems, certified by the State of Michigan. Submit bacteriologist's signature and authority associated with testing. Maintain one copy of each document on site.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. The Contractor shall submit a detailed cleaning and disinfection plan. The plan shall cover the methods and procedure proposed, proposed chemicals, and treatment levels to include coordination, sequence of operations, equipment to be used, the manner of filling and flushing of lines, and the neutralization and disposal of wasted water.

1.4.02 Certification. Certify that cleanliness of water distribution system meets or exceeds specified requirements.

1.4.03 Test Reports. Indicate results comparative to specified requirements. Submit Disinfection Reports for each disinfection event showing type and form of disinfectant used; date and time of disinfectant injection start and time of completion; test locations; name of person collecting samples; initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested; date and time of flushing start and completion; disinfectant residual after flushing in ppm for each outlet tested.

Bacteriological Reports for each test by the Owner will include data on date issued, project name, and testing laboratory name, address, and telephone number; time and date of water sample collection; name of person collecting samples; test locations; initial and 24 hour disinfectant residuals in ppm for each outlet tested; coliform bacteria test results for each outlet tested; certification that water conforms, or fails to conform, to bacterial standards.

PART 2 – PRODUCTS

2.1 MATERIALS. The Contractor shall provide all necessary piping connections, temporary valves, sampling taps, pumps, disinfectant, neutralization agents, chlorine residual test apparatus, and all other items of equipment or facilities required to complete the cleaning disinfection work. Disinfection chemicals shall comply with AWWA B300, Hypochlorite.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that piping system has been cleaned, inspected, and pressure tested.

Perform disinfecting activity after pressure testing, and coordinate work with related systems as required.

3.2 PERFORMANCE.

3.2.01 Cleaning. All potable water lines installed under this contract, including all associated valves and fittings, shall be flushed or cleaned to the satisfaction of the Engineer.

Small pipelines shall be flushed with water at the maximum velocity, which can be developed, but not less than 2.5 feet (0.75 m) per second, unless otherwise permitted by the Engineer. Flushing shall be accomplished through the installed valves or fittings, or through corporation cocks furnished and installed for that purpose.

Pipelines may be flushed as specified, cleaned with a hose, or by other methods acceptable to the Engineer.

Pumps shall be used if required to obtain the necessary volume or velocity of water. Pumping equipment installed under this contract shall not be used for flushing, nor shall the flushing water be passed through them. Temporary bypass piping at each pump shall be provided.

Whenever practical, tests shall be made on sections between valves or sections not exceeding 2000 feet (600 m) in length. Dead ends, bends by hydrants and other fitting shall have a firm foundation and be securely blocked against the trench walls before testing takes place.

3.2.02 Disinfection Procedure**.** The new water lines shall be disinfected in accordance with AWWA C651 by the continuous feed method, slug method, or the tablet method for at least 24 hours. Unless otherwise permitted, the chlorination agent consisting of liquid chlorine, sodium hypochlorite, or calcium hypochlorite shall be injected into the water line at the supply end of each new line or valve section thereof through a corporation cock installed in the top of the pipe. See Table 1 for the dose of chlorine as stated by AWWA C651.

Table 1: Chlorine required to produce 25-mg/L (ppm) concentration in 100 ft (30.5 m) of pipe by diameter.

Pipe Diameter		100 percent Chlorine		1 percent Chlorine Solution	
Inch	*(mm)*	*lb*	*(g)*	*gal*	*(l)*
4	(100)	.013	(5.9)	.16	(0.6)
6	(150)	.030	(13.6)	.36	(1.4)
8	(200)	.054	(24.5)	.65	(2.5)
10	(250)	.085	(38.6)	1.02	(3.9)
12	(300)	.120	(54.4)	1.44	(5.4)
16	(400)	.217	(98.4)	2.60	(9.8)
60	(1500)	2.827	(1281.6)	36.75	(139.1)
72	(1800)	4.07	(1845.1)	52.93	(200.4)

Admission of disinfectant solution into or the flushing thereof through existing mains shall be held to the minimum possible, and then only after proper and adequate measures have been taken to effectively prevent any such solution from entering other areas of the water system. Existing mains which could have been contaminated during work requiring connections to the new water line, involving either tapping or cutting into operations, shall be flushed and disinfected in accordance with Section 9 of AWWA C651.

During disinfection, all valves and hydrants shall be operated to ensure that all appurtenances are disinfected. Valves shall be manipulated in such a manner that the strong chlorine solution in the line being chlorinated will not flow back into the supply line. Check valves shall be used if required.

Flush circulate and clean new water lines until required cleanliness is achieved in accordance with Section 9 of AWWA C651. All chlorinated water discharged to drainage courses shall be neutralized by dilution or chemical treatment. The chlorine residual of wasted water shall not to exceed 4 mg/l (ppm). The manner, disposal point, and rate of discharge shall be acceptable to the Engineer.

3.2.03 Flushing and Sampling. Upon completion of the retention period required for disinfection, flush the pipeline until the chlorine concentration of water leaving the pipeline is no higher than that generally prevailing in the existing system or is acceptable for domestic use.

Dispose of the chlorinated water in conformance with all Federal, State and Municipal laws, ordinances, rules, and regulations. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the chlorinated water to neutralize thoroughly the chlorine residual remaining in the water.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Testing. After final flushing and before the pipeline is connected to the existing system, or placed in service, the Contractor shall employ an approved independent testing laboratory to sample, test and certify the water for conformance with the purity standards of the City of Detroit, the United States Environmental Protection Agency, and the Federal Clean Water Act Health Standards. The Engineer shall be furnished with a copy of such certification by the testing laboratory, and no installation will be approved without such certification.

The Owner may at its discretion, independently perform bacteriological tests on the water lines and the test results shall be binding on the Contractor.

End of Section

SECTION 02676

LEAKAGE TESTS

PART 1 - GENERAL

1.1 SCOPE

The section includes testing for any signs of leakage in all pipelines and structures required to be watertight. Test all other pipelines with water under 250 psi.

Conduct all tests in a manner to minimize as much as possible any interference with the day-to-day operations of existing facilities or other contractors working on the site.

1.2 GENERAL

1.2.01 Related Sections. Related Work specified in other Sections includes:

Section 02620 – Water Main Services
Section 02617 - Steel Water Pipe
Section 15020 – Miscellaneous Piping and Accessories Installation

1.2.02 Governing Standards. Codes and standards referred to in this Section are:

AWWA C 600 - Installation of Ductile-Iron Water Mains

1.3 QUALITY ASSURANCE

1.3.01 Performance Requirements. Provide written notice when the work is ready for testing, and make the tests as soon thereafter as possible.

Personnel for reading meters, gauges, or other measuring devices, will be furnished.

Furnish all other labor, equipment, air, water and materials, including meters, gauges, isolation valves, piping, fittings, blind flanges, smoke producers, blower, pumps, compressors, fuel, water, bulkheads and accessory equipment.

1.4 SUBMITTALS

Provide all submittals as specified in Division 1.

Prior to placing the piping systems in service submit for review and approval a detailed bound report summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 INSPECTION.

Pressure test exposed pipelines for leakage by maintaining the fluid in the pipe at the specified pressure for a period of 60 minutes. Examine all accessible joints during the test. Stop all visible leakage. Test the various pipelines at the test pressures specified.

3.2 VALVES.

Operate valves in the section under test through several complete cycles of closing and opening. In addition, have the test pressure for each valve, when in the closed position, applied to one side of the valve only. Test each end of the valve in this manner.

Test each valve at the same test pressure as that specified for the pipe in which the valve is installed.

Stop all external and internal leakage through the valves.

3.3 REPAIR OF PIPING LEAKS.

3.3.01 Procedures. Repair leaks as follows:

1. Replace broken pipe or joint assemblies found to leak.

2. When leakage occurs in excess of the specified amount, locate and repair defective valves, pipe, cleanouts or joints.

3. If the excess leakage is determined to be caused by defective materials furnished, improper workmanship, or damage to the materials, make the necessary repairs or replacements at no addition to the Contract Price.

4. If defective portions cannot be located, remove and reconstruct as much of the original work as necessary to obtain piping that meets the leakage requirements specified herein and retest, all at no addition to the Contract

Price.

End of Section

SECTION 02730

AGGREGATE BASE AND SURFACE COURSE

PART 1 - GENERAL

1.1 SCOPE. Section includes aggregate base course, aggregate surface course and aggregate shoulder.

1.2 GENERAL.

1.2.01 Governing Standards.

AASHTO (American Association of State Highway and Transportation Officials) M147 – Materials for Aggregate and Soil-aggregate.

AASHTO T180 – Moisture-density Relations of Soils Using a 10 Pound (4.54 kg) Rammer and an 18 inch (45.7 cm) Drop.

ASTM (American Society for Testing Materials) C136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM D1557 – Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft – lbf/ft^3 (2,700 kN – m/m^3)).

ASTM D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).

ASTM D2922 – Test Methods for Density of Soil and Soil-aggregate in Place by Nuclear Methods (Shallow Depth).

ASTM D3017 – Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

MDOT (Michigan Department of Transportation) Standard Specifications for Construction.

1.3 QUALITY ASSURANCE. Perform work in accordance with current edition of MDOT Standard Specifications for Construction, except where modified herein.

1.4 SUBMITTALS.

1.4.01 Samples. Submit, in air-tight containers, 5 lb (2.27 kg) sample of each type of material to testing laboratory. Wherever materials proposed have MDOT designated classifications, submit a certificate of conformance with applicable MDOT specifications for each type of material to be furnished.

1.4.02 Materials Source. Submit name of imported materials suppliers.

PART 2 – PRODUCTS

2.1 MATERIALS.

2.1.01 Aggregate. The coarse aggregate for base course, surface course, or shoulders, may consist of gravel, stone or slag, generally conforming to MDOT Series 21AA, 22A, and 23A, and as modified below.

Stone material shall be crushed rock, crushed boulders, crushed stone, or crushed gravel, and shall consist of angular fragments of hard, durable particles. When gravel is used in the production of stone, all materials before crushing shall be retained on a sieve ½ inch (1.3 cm) larger than the maximum size permitted in the crushed product. The material shall be 100 percent crushed; that is each particle shall have a minimum of one fractured surface. The aggregate shall be reasonably free of clay lumps and other foreign matter.

Crushed slag shall consist of clean, tough, angular fragments of air cooled blast furnace slag, reasonably uniform in density and quality and reasonably free from glassy pieces, coke, dirt, or other objectionable matter. The slag shall weigh no less than 75 pounds per cubic foot (1201.4 kg per cubic meter) dry rodded.

For aggregate bases to be surfaced with bituminous mixtures, Aggregate 21AA shall be used unless otherwise indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECTION. Verify substrate has been inspected, gradients and elevations are correct, and is dry. No aggregate shall be placed until substrate has been approved by Engineer.

3.2 PREPARATION. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting. Unsuitable substrate material shall be excavated to firm soil and replaced with suitable fill when requested by the Engineer. Unless otherwise indicated, suitable fill shall be a type which can be compacted to the density specified, and shall be free from rubbish or debris, vegetable matter, frozen lumps, boulders, large stones, concrete fragments, or other road material, lumber, tree roots, or branches. Blue clay shall not be considered suitable backfill material. Do not place fill on soft, muddy, or frozen surfaces.

3.3 INSTALLATION.

3.3.01 Aggregate Placement. Place aggregate in conformance with Master Specification Section 02730, Base and Surface Aggregation Course and applicable MDOT Standard Specifications for Construction.

3.3.02 Backfill. Excavated earth materials suitable for backfilling behind the aggregate base course, surface course or shoulder shall be deposited and spread in not more than 8 inch (20.3 cm) layers, loose measure, or as directed by the Engineer. Compaction shall be by pneumatic or vibratory type compactors, or other approved methods.

3.3.03 Tolerances. Plus or minus ¾ inch (1.9 cm) from plan dimensions per MDOT Standard Specifications for Construction.

3.4 FIELD QUALITY CONTROL. Compaction testing will be performed in accordance with Section on Roadway Earthwork of the MDOT Standard Specifications for Construction. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

3.5 MAINTENANCE. Completed aggregate base course, surface course and shoulder shall be maintained with grades in a smooth, compacted condition, substantially true to line, grade and cross-section until surface treatment is applied, or the surface is accepted.

End of Section

SECTION 02740

BITUMINOUS PAVING

PART 1 - GENERAL

1.1 SCOPE. Section includes bituminous concrete paving, wearing, leveling or base course, bituminous curbs, and surface sealer.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C40 (American Society for Testing and Materials) – Test Method for Organic Impurities in Fine Aggregates for Concrete.

ASTM C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM C311 – Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete.

ASTM D88 – Test Method for Saybolt Viscosity.

ASTM D95 – Test Method for Water in Petroleum Products and Bituminous Materials by Distillation.

ASTM D139 – Test method for float test for bituminous materials.

ASTM D244 – Test Methods for Emulsified Asphalts.

ASTM D946 – Penetration-Graded Asphalt Cement for Use in Pavement Construction.

ASTM D692 – Coarse Aggregate for Bituminous Paving Mixtures.

ASTM D1073 – Fine aggregate for bituminous paving mixtures.

ASTM D3381 – Viscosity-Graded Asphalt Cement for Use in Pavement Construction.

AASHTO T2 (American Association of State Highway and Transportation Officials) - Saybolt Viscocity.

AASHTO T10 – Spot Test of Asphaltic Materials.

AASHTO T164 – Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.

1996 MDOT Standard Specifications for Construction.

1999 Standard Specifications for Paving and Related Construction, City of Detroit.

1.3 QUALITY ASSURANCE. Perform work in accordance with 1996 MDOT Standard Specifications for Construction, except as modified herein. Obtain materials from same source throughout.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit product information and mix design.

1.4.02 Certifications. Furnish a copy of certification of analysis by the source of all asphalt and aggregate materials before use.

1.4.03 Test Reports. Tests shall be made on bituminous materials by an independent testing laboratory and results of the test furnished to the Engineer for each 1,000 tons of material delivered or as the Engineer may require. Aggregates, not from an MDOT approved supplier, meeting requirements according to test results by an independent testing laboratory, may be used when approved by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Asphalt Cement. In accordance with MDOT Standard Specifications for Construction Section on Bituminous Pavements and Surface Treatment.

2.1.02 Aggregate for Base Course Mix. In accordance with MDOT Standard Specifications for Construction Section on Bituminous Pavements and Surface Treatment..

2.1.03 Aggregate for Leveling Course Mix. In accordance with MDOT Standard Specifications for Construction Section on Bituminous Pavements and Surface Treatment.

2.1.04 Aggregate for Wearing Course Mix. In accordance with MDOT Standard Specifications for Construction Section on Bituminous Pavements and Surface Treatment.

2.1.05 Bituminous Curb Materials. In accordance with MDOT Standard Specifications for Construction Section on Bituminous.

2.1.06 Fine Aggregate. In accordance with MDOT Standard Specifications for Construction Section on Aggregates.

2.1.07 Mineral Filler. In accordance with MDOT Standard Specifications for Construction Section on Aggregates.

2.1.08 Emulsified Asphalt. Emulsified asphalt for bond or top coat shall form to the specific requirements of MDOT Section on Asphaltic Materials for rapid setting anionic asphalt emulsion “SS-1h”.

2.2 PROPORTIONING.

2.2.01 Asphalt Paving Mix. Provide paving mix for each required layer of pavement and bituminous curb in accordance with the current MDOT Standard Specifications for Construction unless indicated otherwise on the drawings.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that compacted granular base is dry and ready to support paving and imposed loads. Verify gradients and elevations of base are correct.

3.2 PREPARATION.

3.2.01 Cleaning Existing Pavement. Before placing bituminous mixture, the existing pavement surface, joints, and cracks shall be thoroughly cleaned of all dirt and debris by compressed air or by the use of mechanical sweepers or hand brooms to permit examination of the existing surface for defects which need to be corrected.

The Contractor shall not place any resurfacing mixture until the condition of the pavement to be resurfaced has been inspected by the Engineer and approved for resurfacing.

The existing surface, including any repaired area and surface treatment subsequently applied, shall be thoroughly clean at anytime any surface treatment is applied, regardless of any previous cleaning.

3.2.02 Cleaning of Alleys. In addition to the cleaning required for resurfacing above, cleaning of alleys shall also include the removal of any loose refuse and/or garbage from the alley and relocating any trash receptacles that are within the resurfacing area.

Also included is the trimming back of any bushes or tree branches that would impede the asphalting operations.

3.2.03 Conditioning. Conditioning existing pavement includes joint and crack cleanout, jointed crack repair, removing bituminous patches and other work specified herein.

When called for on the plans, or as directed by the Engineer, clean joints and cracks by clean joints and cracks by removing joint sealants to a depth of up to one inch (2.5 cm) from transverse and longitudinal joints and from cracks by mechanical or hand methods.

Repair joints and cracks in accordance with the details shown on the plans.

Remove all “cold patched” areas designated by the Engineer, to the full depth of the bituminous surface. The edges of such areas shall be trimmed to a fairly vertical face and then lightly painted with asphalt emulsion SS1-h. The areas shall be filled with hot binder course mixture brought to a compacted level of the abutting old surface by rolling.

Prior to placing any bituminous concrete surfacing, the existing pavement which is to be used as a base course shall be prepared in accordance with the following procedure: All broken surfacing not bounded to the pavement or to other bituminous surfacing, including badly cracked or patched areas, which in the opinion of the Engineer, may cause instability or bleeding, shall be removed. The edges of such areas shall be trimmed to a fairly vertical face. All random cracks 1 inch (2.54 cm) or more in width shall be cleaned. Deteriorated surface adjacent to any random crack shall be removed. On pavement not previously surfaced, joints and cracks 1 inch (2.54 cm) or more in width shall be cleaned of any filler, sealer or foreign materials to a depth of at least one inch (2.54 cm) below the pavement surface or as directed by the Engineer. The removal of bituminous concrete surface either by the standard or planer method shall be performed as directed by the Engineer.

All underlying loose, deteriorated concrete base shall be removed by thorough sweeping with a power broom, compressed air jet, air hydraulic tools or other means approved by the Engineer. All existing or resulting holes, ruts, cracks, and depressions in the existing concrete pavement or bituminous concrete pavement surface shall be swept or blown clean of dust, dirt or other loose material, and the resulting areas sprayed with bond coat material and completely refilled with bituminous mixture as directed by the Engineer. The mixture shall be thoroughly compacted by mechanical tamping or rolling. All areas cleaned during the day shall be patched and repaired as specified above by the end of the day’s work.
The bituminous mixtures required for filling of holes and areas where deteriorated bituminous material has been removed shall be as directed by the Engineer and will be selected from the mixtures specified in the MDOT Standard Specifications for

Construction Section on Bituminous Pavements and Surface Treatments. The mixture selected by the Engineer will be dependent on the depth and size of the patch and the type of mixture and penetration grade of the asphalt cement required for the project. The patches shall be compacted to the required grade by use of machine vibrator or approved roller.

Place leveling or wedge courses of binder material to bring the existing surface to a uniform contour, where indicated, machine placed and rolled in layers as directed by the Engineer.

3.2.04 Stripping of Existing Asphalt Surface. Where the existing asphalt surface is shattered, broken, or not properly bonded to the concrete base to such an extent that it provides an unsuitable foundation, or it is necessary to remove the old surface to provide a proper grade and crown, it shall be stripped and removed to the extent directed by the Engineer. Any existing bituminous patch which, in the judgement of the Engineer, may cause instability of the final wearing course shall likewise be removed.

The inspector and the Contractor's representative shall measure the pavement stripped, and this shall be summarized on a report, showing the size and location of the various areas. This measurement shall be taken before the application of the resurfacing materials.

In the areas to be stripped, the material shall be loosened with air hammers and the perimeter of the stripped area cleaned and shaped with hand tools.

3.2.05 Strip and Adjust Asphalt Surface. Stripping and adjusting asphalt surface consists of the stripping of the existing asphalt surface to the base pavement, adjusting the existing base pavement so that it serves as a satisfactory foundation for the rebuilt asphalt, and furnishing and applying the bond coat, binder course mixture and the wearing surface mixture.

3.2.06 Concrete Base Removal and Replacement. Loose or disintegrated concrete 9in the exposed pavement base shall be removed to the extent deemed necessary by the Engineer. The means and methods used shall be such as to not damage or loosen adjacent pavement areas. The edges of existing concrete left in place shall be so cut and shaped that proper bond may be obtained between the old and new concrete. The existing concrete shall be properly wetted prior to the placement of the new replacement concrete.

The space left by the removal of the existing concrete shall be filled with Grade A (4000 psi (27,579.2 kPa) concrete, thoroughly compacted and brought up to conform to the required grade and contour of the underside of the new binder course mixture. The poured concrete shall be protected until it has developed sufficient strength to prevent damage from application of the new surfacing materials or other causes.

3.2.07 Fills. Depression or voids in the pavement sub-base and around manholes that are being adjusted shall be filled with Grade C (2000 psi (13,289.6 kPa) concrete or compacted granular material, as directed by the Engineer. Isolated fills requiring less than ½ cubic yard (0.38 cu m) of fill material shall be made without additional cost to the Owner. Fills of ½ cubit yard (0.4 cu m) or more, when required by the Engineer, will be paid for as extra work.

3.2.08 Preparation Of Existing Pavement. Preparation of existing pavement includes butt joint cutting, chipping concrete pavement for joints and resetting frames of manholes, catch basins and boxes.

Connections with the existing surfaces at the beginning and end of resurfacing sections and at intersections with other pavement shall be made by cutting the old pavement surface to give a butt joint to a depth equal to the thickness of the proposed overlay. The old surface shall be cut back not less than 3 feet (91.44 cm) the full width of the joint.

When a butt joint is specified, the existing concrete surface shall be tapered back to a minimum of 30 feet (9 m) or as shown on the plans to a depth of a least 1-1/2 inches (40 mm), for the full width of the joint.

Existing manholes, catch basins, stop boxes, survey control monuments boxes, etc., shall be raised where necessary so that their exposed areas will be flush with the finished new wearing surface. For one-course pavement resurfacing, existing catch basins shall be reset only when so directed by the Engineer. Resetting of manholes, catch basins, and stop boxes shall be done after placing of the binder course.

A sufficient amount of the adjacent existing pavement surface shall first be removed to permit removal of a casting without damage. Any casting damaged by the Contractor in removal or resetting shall be replaced by him with a new casting without additional cost to the Owner. Any existing casting or stop box which is in a damaged condition prior to the Contractor's operations and which, in the judgement of the Engineer, is not suitable for resetting shall be replaced.

Castings shall be supported at the new elevations on collars of Grade A concrete or brick masonry so formed and constructed as to hold the casting firmly and permanently in place, except as follows. Where an existing manhole or catch basin of a type not requiring replacement is securely embedded in the existing pavement and needs only to be raised to the new surface grade, an adaptor shall be used when so directed by the Engineer. Manhole adaptors shall be in accordance with the Standard Plans and catch basin adaptors with the Standard Plans. Stop boxes shall not be raised by means of a metal collar ring.

For a catch basin of an obsolete type, such as the so-called Stuart basin having metal back plate requiring removal and discarding in order to raise the casting proper, the destroyed curb area back of the metal plate shall be replaced with Grade A concrete, finished to conform with the surface of the adjacent curbing.

All holes in the existing pavement around the reset castings shall be filled by using an applicable method as approved by the Engineer.

3.2.09 Rebuilt and Semi-Rebuilt Catch Basin. Catch basins requiring rebuilding, as determined by the Engineer, shall be completely rebuilt in accordance with the Standard Plans.

Catch basins requiring semi-rebuilding only, as determined by the Engineer, shall be rebuilt in accordance with the Standard Plans. Such semi-rebuilding shall consists of rebuilding no more than the top pipe section or 6 to 9 courses of brick.

3.2.10 Abandoned Streetcar Tracks. Existing streetcar tracks shall be removed and the area filled in and covered by resurfacing materials unless otherwise specified.

The track drain frames and covers shall be removed and disposed of by the Contractor. The manhole frames and covers on “dead” manholes shall likewise be removed and disposed of by the Contractor. Care shall be taken to determine if the particular manhole is “dead” or is still in use.

All abandoned manholes and track drains shall be cleaned out, the inlets and outlets plugged with concrete, and the manhole backfilled in the same manner as specified for a sewer trench, or the manhole completely filled with Grade “C” concrete.

3.2.11 Removing Bituminous Surface. This applies to the removal of the bituminous surface, regardless of thickness or width, where it overlies a base course that is to remain in place, and includes the construction of butt joints.

The bituminous surface shall be removed to the depth, width, grade, and cross-section as shown on the plans, or as directed by the Engineer.

Where material is removed below the grade specified due to poor cold-milling practice, the resultant holes or depressions shall be backfilled and compacted. Such work shall be at the expense of the Contractor.

The material which is picked up by sweeping after cold-milling shall not be incorporated in the bituminous mixture nor used as fill.

If the material removed from the pavement is not salvaged for use in recycled mixture for the project, or a subsequent project, the Contractor shall dispose of the material in accordance with Division 1, section on Contract Closeout and Cleaning.

Where it is desirable in the opinion of the Engineer to remove the existing pavement surface to provide a better grade, the existing surface shall be removed by means of a power operated planing machine or grinder capable of removing a layer of material 6 feet (1.8 meters) in width and 2 inches (5.1 cm) in depth.

The equipment shall be capable of accurately establishing profile grades by referencing from either the existing pavement or from an independent grade control, and shall also have an effective means for removing excess material from the surface while preventing any dust resulting from the operation from escaping into the air.

If the grinder cannot remove the material to the curb face, the method of removing the material adjacent to the curb face shall be approved by the Engineer. Any excess bituminous material removed shall be replaced and any damage to the existing curb shall be repaired by the Contractor at no cost to the project. In no case shall the use of a grader, front end loader, or bulldozer, be allowed to clean the remaining material to the curb face.

The bituminous surface shall be removed to a depth of 2 inches (5.1 cm) at the gutter tapering to zero depth at 6 feet (1.8 m), or as shown on the plans as directed by the Engineer. Removal in the vicinity of bridges and/or viaducts shall be uniform 2 inches (5.1 cm) depth from curb to curb commencing approximately100 feet (30 m) from either side of the structure. On streets designated for curb to curb removal, bituminous surface shall be removed to a uniform depth from curb to curb, as directed by the Engineer. The bituminous surface at all intersections shall be removed where necessary to form a smooth transition between abutting existing pavement and the proposed pavement. Excess material resulting from the operation shall be removed immediately as the work progresses and disposed of in an approved manner. Accumulations of material which might interfere with drainage or might constitute a hazard to traffic will not be permitted.

Prior to milling, the Contractor may lower all existing castings of manholes, water gates, stop boxes and other miscellaneous castings in the area of pavement milling. The lowering shall be to the depth of the proposed milling but in no case shall exceed one inch (2.5 cm) more than the depth of the proposed milling.

A sufficient amount of adjacent existing pavement, not to exceed a maximum of 12 inches (30.5 cm) beyond the visible outline of casting, shall first be removed to permit removal of the casting without damage. Any casting damaged by the Contractor in removing pavement or lowering shall be replaced by him with a new casting at no additional cost to the Owner.

The method used by the Contractor to remove the adjacent existing pavement around the castings shall be approved by the Engineer.

Chipping and cleaning around the existing catch basins shall be completed immediately after the milling operation.

All catch basins and manholes within the milling area shall be covered by an acceptable method, prior to the milling operation, to prevent any of the milling material from entering the structures. Any of the milling material that falls into the catch basins or manholes shall be removed by the Contractor without additional cost to the Owner.

All depressions in the existing pavement resulting from the lowering off the castings shall be filled with cold patch material. With the approval of the Engineer, cold patching may be eliminated if the milling operation follows immediately after lowering the castings, in either case, the streets shall be left in a safe condition for traffic.

If the Contractor exercises the option or lowering, castings prior to milling, no additional compensation will be allowed for any of the work or materials used in the lowering of the castings or in adjusting the castings to the finished elevations.

3.2.12 Application. The prepared surface shall be treated with a bituminous bond coat. Apply bond coat to prepared surface in accordance with the MDOT Standard Specifications for Construction at an application not between 0.10 and 0.15 gallons per square yard (0.45 and 0.68 liters per square meter). No bond coat shall be applied on wet or moist base and no pools of bituminous material shall be allowed to remain on the surface. Distributors shall be equipped with approved temperature and volume indicators and quick shut-off spray bars to avoid dripping.

3.3 INSTALLATION.

3.3.01 Bituminous Base Course Placement. The base course shall be constructed only on a clean foundation in accordance with the MDOT Standard Specifications for Construction unless otherwise indicated on the drawing. The mixture shall be delivered and placed at a temperature between 275 degrees F (13.5 degrees C) and 325 degrees F (162.8 degrees C). It shall be dumped into a mechanical spreading machine which shall strike off and screed the mixture in layers not to exceed 3 inches (7.62 cm) or as called for on the drawings. Spreading shall start at the sides and progress to the center in strips of uniform width.

3.3.02 Bituminous Leveling Course Placement. The leveling course shall be constructed only on a clean foundation in accordance with the MDOT Standard Specifications for Construction unless otherwise indicated on the drawing. The mixture shall be delivered and placed at a temperature between 275 degrees F (135 degrees C) and 325 degrees F(162.8 degrees C). It shall be dumped into a mechanical spreading machine which shall strike off and screed the mixture in layers not to exceed 3 inches (7.62 cm) or as called for on the drawings. Spreading shall start at the sides and progress to the center in strips of uniform width.

3.3.03 Bituminous Wearing Course Placement. The wearing course shall be constructed only on a clean foundation after preparation or on completed binder course in accordance with the MDOT Standard Specifications for Construction, unless otherwise indicated on the drawings. It shall be constructed in the same manner as leveling course and the thickness shall be as shown on the drawings.

The wearing surface shall be feathered to provide a transition between existing and new surfaces at all intersections and/or limits of resurfacing projects.

The wearing surface shall have a minimum thickness of 1 ½ inches (3.8 cm). Where the minimum thickness of 1 ½ inches (3.8 cm) cannot be maintained, the existing surface shall be milled to permit the placing of a minimum of 1 ½ inches (3.8 cm) of wearing surface.

3.3.04 Smoothness Requirements. After final rolling, the surface may be tested longitudinally by the Engineer using a straightedge at selected locations. Use MDOT Materials Testing Manual Protocol 722 to determine locations. Variations in the surface shall not exceed the current MDOT Standard Specifications for Construction.

For Bituminous Base Course Mixtures:

Lower Courses: 0.8 inches (20 mm)
Top Course: 0.4 inches (10 mm)

For Leveling and Top Course Mixtures:

Multiple Course Construction:	0.125 inches (3 mm) for top course
	0.25 inches (6 mm) for lower courses
Single Course Construction:	0.25 inches (6 mm)

3.3.05 Bituminous Curb Placement. Bituminous curb shall be placed using a bituminous curbing machine.

3.3.06 Protection. Immediately after placement, protect pavement from mechanical injury for 24 hours.

3.3.07 Backfilling. When the area behind the curb is to be backfilled, the backfilling shall not commence until the mixture has been allowed to cure for approximately 24 hours, unless otherwise approved by the Engineer. The backfill material shall be placed and thoroughly tamped and compacted to the satisfaction of the Engineer, without disturbing the curb, and shall be left in a neat condition.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. Perform field density testing and extract cores for testing in accordance with the MDOT Standard Specifications for Construction.

End of Section

SECTION 02750

CONCRETE PAVEMENT

PART 1 – GENERAL

1.1 SCOPE**.** This work shall consist of furnishing and constructing a jointed Portland cement concrete pavement, alley pavement, concrete base course or concrete shoulder, with or without reinforcement, as shown on the plans or as directed by the Engineer. The work also includes curbs, curb and gutter, and integral curb and sidewalk. This work shall be done in accordance with sections 4.50, 4.52 and 6.09 of the 1990 Michigan Department of Transportation (MDOT) Standard Specifications for Construction, and as specified in the Standards of the County, City or Township having jurisdictional authority, as well as the 1999 Standard Specifications for Paving and Related Construction for the City of Detroit, Department of Public Works, City Engineering Division. The types of concrete paving will be as classified in Section 4.50.02 of the current MDOT Standard Specifications for Construction.

1.2 GENERAL.

1.2.01 Governing Standards.

AASHTO (American Association of State Highway and Transportation Officials) M33 as Revised – Preformed Expansion Joint Filler for Concrete (Bituminous Type).

AASHTO M213 as Revised - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

AASHTO T26 as Revised - Standard Method of Test for Quality of Water to be Used in Concrete.

AASHTO T96 as Revised - Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine.

ACI 301 (American Concrete Institute) – Specifications for Structural Concrete for Buildings.

ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

ASTM (American Society for Testing and Methods) A185 – Steel Welded Wire Fabric, Plain for Concrete Reinforcement.

ASTM A497 – Steel Welded Wire Fabric, Deformed for Concrete Reinforcement.

ASTM A615/A615M – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM C31/C31M – Practice for Making and Curing Concrete Test Specimens in the Field.

ASTM C33 – Concrete Aggregates.

ASTM C39/C39M – Test Method for Compressive Strength of Cylindrical Concrete Specimens.

ASTM C42/C42M – Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

ASTM C94/C94M – Ready-Mixed Concrete.

ASTM C136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM C143/C143M – Test Method for Slump of Hydraulic Cement Concrete.

ASTM C150 – Portland Cement.

ASTM C172 – Practice for Sampling Freshly Mixed Concrete.

ASTM C173 – Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

ASTM C174/C174M - Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.

ASTM C231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

ASTM C260 – Air-Entraining Admixtures for Concrete.

ASTM C309 – Liquid Membrane – Forming Compounds for Curing Concrete.

ASTM C494 –Chemical Admixtures for Concrete

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ASTM C595 – Blended Hydraulic Cements.

ASTM C666 – Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

ASTM D98 – Calcium Chloride.

ASTM D1751 – Preformed Expansion Joint Filler for Concrete Paving and Structural Construction.

ASTM D1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

Fed. Spec SS-S-164 Sealing Compound, Hot Poured Type, for Joints in Concrete.

1.3 QUALITY ASSURANCE. Perform work in accordance with 1990 MDOT Standard Specifications for Construction Sections 2.08, 6.09 and 6.11 and as specified in the standards of the County, City and Township having jurisdiction as well as the 1999 Standard Specifications for Paving and Related Construction for the City of Detroit.

Obtain cementitious materials from same source throughout.

1.3.01 Testing. The Contractor shall make cylinders for compressive strength tests as well as slump tests for consistency and tests for air content concurrently at the job site. These tests shall be made for all exposed concrete used in commercial driveways, building construction; concrete paving projects; repairs of public streets, alleys, sidewalks, curbs and driveways; new curbs, sidewalks and driveways; and/or at such locations deemed necessary by the Engineer for quality control of concrete placed on public property.

A minimum of one test for slump and one test for air content shall be taken for each 25 cubic yards (19.1 cu m), or portion thereof, of concrete placed. Should test results so dictate, the Engineer may order additional testing to assure quality concrete. Tests for entrained air and slump of concrete may also be made by the Engineer when concrete is being placed.

Air content tests shall be in accordance with ASTM C231 or C173. The concrete, when deposited in the forms for pavements or curbs, shall contain 6 percent (plus or minus 1 percent) of entrained air.

The consistency of concrete mixes will be determined by the slump cone test as specified in the method of test for slump of Portland Cement Concrete ASTM C143.

The consistency of the concrete shall not exceed the limits listed below:

Concrete for street pavement including base course and curbs shall have a maximum slump of 3 inches (7.6 cm).

Concrete for alley pavement and cubs shall have a maximum slump of 4 inches (10.1 cm).

Concrete for sidewalks and driveway paving shall have a maximum slump of 5 inches (12.7 cm).

For any single batch, slump tests of individual samples taken at approximately the one-quarter and the three-quarter points of the load shall differ by not more than 1 inch (2.5 cm).

Compression test specimens shall be prepared in accordance with ASTM C31 with 1 set of 4 standard cylinders for each compressive-strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.

Compressive-strength tests shall follow ASTM C39 with 1 set for each day's pour exceeding 5 cubic yards (3.82 cu m) plus additional sets for each 50 cubic yards (38.2 cu m) more than the first 25 cubic yards (19.1 cu m) of each concrete class placed in any 1 day. Test 1 specimen at 7 days, 2 specimens at 28 days, and hold 1 specimen in reserve for later testing if required.

1.4 SUBMITTALS.

1.4.01 Mix Design. Submit certification that concrete mix conforms to specified MDOT mixes. Submit three copies of the mix design for approval for all non-MDOT concrete mixes.

1.4.02 Product Data. Submit data on joint filler, admixtures, and curing compounds.

1.5 DELIVERY, STORAGE, AND HANDLING. Concrete materials shall be so furnished, handled, and stored as to preclude inclusion of foreign matter and permit easy access for inspection. Storage facilities shall be sufficient and so stocked and maintained as to assure concrete placement at the required rate without damaging delays. Handling methods and storage facilities shall be subject to the approval of the Engineer.

Cement shall be so handled and stored as to be protected from the weather, dampness, and contamination. Cement shall be used in the same relative order as received. Cement salvaged or reclaimed from cleaning sacks, leaking containers, or discarded sacks shall not be used. Any cement which, for any reason, has become partially set, contains lumps of caked cement, or is in any way contaminated shall be rejected and shall be promptly removed from the site.

Aggregates shall be so furnished, handled, and stored as to insure uniformity of the specified grading at the time of batching, and that the moisture content will be reasonably constant for each day's run. Aggregate requiring pre-washing shall not be used until the surplus water has disappeared and the material has a uniform and acceptable water content.

Fine and coarse aggregates, aggregates from different sources, and various classes of coarse aggregates shall be separately stored.

PART 2 – PRODUCTS

2.1 MATERIALS.

2.1.01 General. Concrete shall be composed of a mixture of Portland cement, fine aggregate, coarse aggregate, fly ash, admixtures when specified and water. The materials and methods used shall produce a dense, homogenous impervious, durable and workable concrete of the highest quality and without defects of any kind.

The materials shall meet the requirements specified in the MDOT Standard Specifications for Construction as follows unless otherwise indicated on the drawings

Concrete, 30P, 35P, 35HE	Section 7.01
Mortar and Grout	Section 7.02
Steel Reinforcement	Section 8.05
Joint Materials	Section 8.16
Curing Materials	Section 8.24

For instances where an MDOT mix is not specified, provide concrete as follows unless indicated otherwise on the Drawings: Grade "A" concrete shall be used throughout the work except that Grade "C" concrete may be used for backfills, unless stronger concrete is called for on the plans.

Grade "A" concrete shall have a minimum compressive strength of 4,000 psi (27,579 kPa) at 28 days and shall contain not less than 6 1/2 sacks of cement per cubic yard (8 1/2 sacks of cement per cubic meter) of concrete. Grade "C" concrete shall have not less than 3 sacks of cement per cubic yard (4 sacks of cement per cubic meter) of concrete.

2.1.02 Water. Water used in concrete or mortar mixtures or for curing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. DWSD furnished potable water may be used without testing.

For water requiring testing, the tests will be conducted in accordance with AASHTO T26. Water from sources other than City tap water shall meet the following requirements:

Total solid matter, max	0.03%
Organic matter, max	0.05%
Alkalinity – Acidity	Natural to litmus

Water failing to meet these requirements may be approved for use if, when comparative tests are made between the proposed water and distilled water, using an approved cement, there is no indication of unsoundness, marked change in time of setting, or a reduction of more than 10 percent in mortar compressive strength.

The water intake shall provide for the exclusion of silt, mud, grass, or other foreign materials.

2.1.03 Cement. Cement for pavement, base course, curbs, sidewalk and shoulder, as called for on Plans or as directed by the Engineer shall be “Portland Cement” conforming to the respective requirements of the applicable ASTM specifications listed below. Cement of only one kind and type shall be used throughout the work and it shall be a standard brand of a single producer, unless otherwise specifically authorized by the Engineer.

Portland Cement Types I, IA, III and IIIA shall conform to ASTM C150. The requirements for Gillmore Setting Time Test and compressive strength through the 28 day test shall apply.

Portland Cement Types IS and IS-A Blast-Furnace Slag shall conform to ASTM C595.

2.1.04 Fine Aggregate (Sand). Fine aggregate shall be natural sand consisting of fine granular material resulting from the natural disintegration of rock or manufactured sand or a combination thereof. The sand shall consist of clean, sound, durable particles free from any adherent coating, clay lumps or other deleterious substances, and at the time of use shall be entirely free of frozen material.
Fine aggregate shall conform to the requirements of the current MDOT Standard Specifications for fine aggregates for portland cement concrete, natural sand, Type 2NS.

2.1.05 Coarse Aggregate. Coarse aggregate shall consist of gravel, stone or slag all of which shall conform to the current MDOT Specifications for Type 6AA. Coarse aggregate shall be used in all concrete permanently exposed to the weather.

2.1.06 Admixtures. Admixtures include all materials other than water, aggregates, and Portland Cement that are used in the making of concrete and that are added to the batch immediately before or during the mixing.

Admixtures, other than Air-Entraining admixture conforming to the requirements of ASTM C260, shall not be used in the concrete without the prior written approval of the Engineer.

Admixtures that may be used with written approval of the Engineer are Calcium Chloride per ASTM D98, Type 1 regular flake and water reducing admixtures ASTM C494 Type A and Type D.

2.1.07 Joint Materials. Filler for expansion joints shall be premolded bituminous, ASTM D1751. Filler for contraction joints shall be bituminous joint filler, AASHTO M33. Filler for curb expansion and contraction joints shall be premolded bituminous, ASTM D1751 or AASHTO M213 Type III.

Poured joint filler shall be hot-poured rubber-type compound, Fed. Spec. SS-S-164.

2.1.08 Forms. Pavement and curb forms shall be straight and free from distortion, and of sufficient strength to resist forces applied during the process of placing concrete against them. The forms shall be of an approved section, with a flat surface on top, and shall be of the full depth of the pavement or curb.

Forms for radius corners shall be steel or thin board, accurately formed to true radius, and held by bracing and stakes to maintain a true curve.

2.1.09 Fill Materials. Earth materials excavated under this Contract, to be suitable for backfill behind the curb or integral curb and sidewalk, the filling of low places in a strip 2 feet (61.0 cm) wide and paralleling the constructed curb, and integral curb and sidewalk shall be a type that may be thoroughly compacted by the method specified. Such material, to be useable, shall be free from rubbish or debris, vegetable matter, large stones, concrete fragments or other road material, lumber, tree roots, or branches. In general, select excavated material to be suitable for backfill shall be restricted to sand or crumbly clay, unless indicated otherwise.

2.2 PROPORTIONING.

2.2.01 Design Mixture. The mixing proportions (approximately 1:2:3 mix) and water-cement ratio used shall be such as to produce a dense, homogenous, workable and durable concrete having a minimum compressive strength of 4,000 psi (27,579 kPa) at 28 days, unless indicated otherwise on the Drawings.

The concrete mix design to produce a concrete of the required minimum strength shall be the sole responsibility of the Contractor, except that no less than 6 1/2 sacks of cement per cubic yard (8 1/2 sacks of cement per cubic meter) shall be used and the mixing water shall not be more than 5 1/2 gallons (20.8 liters) per sack of cement, including the surface moisture carried by the aggregates, both fine and coarse. The maximum allowable slump shall be that consistent with the proper placement of the mix, but in no case shall the water content exceed that specified. The Engineer will check the Contractor’s proposed concrete design mix. Mixes which do not produce concrete of required quality shall be adjusted, at the Contractor’s sole expense, until all the requirements of these specifications are complied with.

The Grade of concrete to be used in the various parts of the work shall be as stipulated below, unless otherwise called for on the Plans.

Grade	Use
“A”	Concrete pavement, alley pavement, curbs, commercial drives, pavement base, residential drives, and sidewalks.
“C”	Backfill where called for on plans or as directed by the Engineer.

Grade “A” concrete may be used in the place of Grade “C” concrete, without additional cost to the Owner.

High-Early-Strength Concrete installation and mix design shall be subject to the approval of the Engineer for each location shown on the Plans, or as directed by the Engineer.

PART 3 – EXECUTION

3.1 INSPECTION. Verify compacted subgrade or granular base as applicable is acceptable and ready to support paving, curbs, curb and gutter, integral curb and sidewalk and imposed loads.

Verify gradients and elevations of subgrade or base are correct.

3.2 PREPARATION. Prepare subgrade or base in accordance with Section 2.08 of the MDOT Standard Specifications for construction unless indicated otherwise on the drawings. Replace unsuitable subgrade soils with approved suitable materials. Moisten base to minimize absorption of water from fresh concrete.

Coat surfaces of manhole, catch basin and other metal frames and covers with oil to prevent bond with concrete pavement.

Notify Engineer a minimum of 24 hours prior to commencement of concreting operations.

3.2.01 Forming. Place and secure forms to correct location, dimension, profile, and gradient. Forms shall be adequately staked and braced to resist the pressure of the concrete. All forms shall be thoroughly cleaned and oiled before concrete is placed against them.

Assemble formwork to permit easy stripping and dismantling without damaging concrete.

Place joint filler vertically in position, in straight lines. Secure to formwork during concrete placement.

3.3 INSTALLATION.

3.3.01 Batching, Mixing and Transporting Concrete. Ready-mixed concrete from an approved source shall be used unless on-the-site mixing is authorized by the Engineer. The plant and transportation equipment and the methods used for producing and delivering the ready-mixed concrete shall conform to the current ASTM Standard C94 except as otherwise modified or specified herein.

The plant and transportation equipment of the ready-mix concrete source shall be available for assignment to this work and shall be of adequate size and sufficient capacity to maintain a satisfactory job progress schedule. Concrete materials shall be stocked in such quantities as required to meet maximum demands. Trucks delivering ready-mixed concrete for alley paving shall be equipped with exhaust systems venting upward over the cab.

A “Transit Mix Concrete Producer’s Certificate”, furnished by the City Engineering Department, shall be used in lieu of the certification called for in Section 16 of ASTM C94. Such certificate, completely filled out and signed by an authorized agent of the producer, shall accompany each truck load of ready-mix concrete and be presented to the Engineer or Inspector prior to unloading at the site as a condition for the use of concrete in the work. The person signing shall be one who has previously been officially designated by the producer as authorized agent and whose signature is currently on file with the Engineer of Inspection for the Detroit Water and Sewerage Department.

The Engineer's determination of "Failure to Meet Strength Requirements" of ASTM C94, shall be final and conclusive upon the Contractor. Such determination will be based on tests and other factual data deemed pertinent by the Engineer.

On-the-site batching and mixing equipment and methods, when authorized, shall be such that will produce concrete comparable in all respects to ready-mixed concrete meeting the specified requirements.

3.3.02 Erection. Curbs of all types shall not have reinforcing steel extend through transverse expansion and contraction joints.

3.3.03 Separate Type Curb Construction – Unreinforced and Reinforced Construction. The curbs shall be constructed in conformance with the types and details as specified on the plans. When steel reinforcement is called for on the plans, it shall be properly spaced and held in the correct position during the placing of concrete by the use of devices or methods meeting the approval of the Engineer.

Splicing of steel reinforcement bars shall be accomplished by lapping and securely wiring the bars together. The bars shall be lapped at least 10 inches (25.4 cm), unless otherwise shown on the Plans.

The concrete shall be spaded sufficiently to eliminate all voids and tamped to bring the mortar to the surface.

Joints shall be constructed perpendicular to the surfaces of the structure and shall not vary more than 1/4 inch (6.4 mm) from their designated positions.

Expansion joints in un-reinforced curb shall be 1 inch (2.54 cm) thickness, with curb size premolded bituminous fiber filler, shall be placed through the curb at the end of the street and alley returns at 50 feet (15.2 m) intervals, or at such lesser distances when necessary to retain the 50 foot (15.2 m) interval between existing expansion joints remaining.

Expansion joints in reinforced curb shall be 1 inch (2.54 cm) thickness, with curb size premolded bituminous fiber filler, shall be placed through the curb at the end of street and alley returns and in line with all expansion joints in the abutting pavement.

The curb shall be constructed in uniform sections of a length not longer than 10 feet (3.1 m) except when otherwise shown on the plans. Provide separation joints at 10 foot (3.1 m) intervals between expansion joints. Separation joints shall be formed by a steel template 1/8 inch (3.2 mm) in thickness, of a width equal to the required width of the curb, and depth of at least 2 inches (5.1 cm) greater than the required depth of the curb, set vertically within the forms and at right angles to the curb face. Finding of separate type curb shall be as specified for Reinforced Curb and Gutter.

3.3.04 Reinforced Integral Curb and Gutter Construction. The reinforced integral curb and gutter shall conform to the cross-section shown on the plans. The reinforced integral curb and gutter shall be constructed to the grade shown on the Drawings, unless otherwise directed by the Engineer. Integral curb shall be constructed monolithic with the pavement slab. The curb material shall be placed before the pavement has started its initial set, and shall be of the same mix and be identical to the concrete in the pavement.

The curb and gutter forms shall be substantial and so placed and held as to be unyielding during the placing, compaction, and curing of the concrete.

The concrete shall be carefully placed to avoid segregation and shall be sufficiently spaded or vibrated to eliminate all voids and taped to bring the mortar to the surface.

The longitudinal bars called for on the plans shall be properly spaced and held in correct position during the placing of concrete by use of bar chairs, hangers, or other devices approved by the Engineer. Longitudinal bars shall end 2 inches (5.1 cm) from each expansion or contraction joint.

Splicing of steel reinforcement bars shall be accomplished by lapping and securely wiring the bars together. The bars shall be lapped at least 10 inches (25.4 cm).

Expansion joints of 1/2 inch (1.3 cm) thickness, with curb size premolded bituminous fiber filler shall be placed through the curb at 60 foot (18.1 m) intervals, or at such lesser distances when necessary to retain the 60 foot (18.1 m) intervals between existing expansion joints remaining.

The bottom of the premolded filler shall be set 1 1/2 inches (3.8 cm) below the bottom of the pavement. The joint shall be free from concrete and the end of the joint cleaned of hardened concrete as soon as the forms are removed.

During installation, the joint shall be held in place by an approved installing device which shall be securely staked. The top edge of the filler shall be protected, while the concrete is being placed, by a metal channel cap of at least 10 gage (3.5 mm) thickness material having flanges not less than 1 1/2 inches (3.8 cm) in depth. The channel cap shall be shaped to the contour of the pavement and shall extend over the filler from gutter line to edge of pavement. A premolded filler of the full depth, width, and cross-section of the curbs shall be placed at the channel cap end and shall make a positive separation between curb and gutter sections.

Reinforced integral curb and gutter shall be constructed in uniform sections of a length not longer than 20 feet (6.1 m). Provide separation joints at 20 foot (6.1 m) intervals between expansion joints shall be formed by a steel template, 1/8 inch (3.2 mm) thickness, of a width equal to the required width of the curb and gutter and depth of at least 2 inches (5.1 cm) greater than the required depth of the curb, set vertically within the forms and at right angles to the curb face.

The edges and back top edge of the curb and all transverse joints and planes of weakness shall be rounded with an approved finishing tool having a radius of 1/4 inch (6.4 mm). The face of the curb, at the top of all curb and at the bottom of the integral curb, shall be rounded with approved finishing tools having the radii shown on the plans. When the concrete has set sufficiently to prevent slumping the face form shall be removed and the exposed surfaces of the concrete curb or curb and gutter shall be finished smooth and even by means of a moistened wood float, followed by a light brushing, using either a broom, brush or burlap. The top of curb shall not vary more than 3/16 inch in 10 feet (4.7 mm in 3.1 m) when checked with a 10 foot (3.1 m) straightedge. The balance of the exposed surfaces shall not vary more than 3/8 inch (9.5 mm) from the alignment and typical cross-section.

Water shall not be added to the concrete surface as an aide to finishing, except in isolated instances where a delay in finishing has occurred and evaporation has caused a loss of surface moisture. Water added in these instances shall be minimal and then only when approved by the Engineer.

Honeycombed areas and minor defects shall be filled with mortar, prior to applying membrane curing compound. Use mortar conforming to Type R-2 per Section 7.02.03 of the MDOT Standard Specifications for Construction unless indicated otherwise on the drawings.

3.3.05 Alley Curb Construction. The curbs shall be constructed in conformance with the types and details as specified on the plans. All curbs, including circles at intersections, shall be integral roll curb, unless otherwise specified on the plans or in the proposal for the contract.

The concrete shall be placed and spaded sufficiently to eliminate voids so that the roll curb and slab shall form an integral unit.

Expansion joints in the slab shall be carried through the integral roll curb.

Contraction joints in the integral roll curb shall be placed at all contraction joints in the slab and shall be of the same type of construction.

The edges and back top edge of the curb and all transverse joints and planes of weakness shall be rounded with an approved finishing tool having a radius of 1/4 inch (6.4 mm). The face of the curb, at the top of all curb and at the bottom of the integral curb, shall be rounded with approved finishing tools having the radii shown on the plans. The exposed surfaces of the curb shall be finished smooth and even. Neat cement shall not be used as a dryer to facilitate the finishing of the surface.

3.3.06 Integral Curb and Sidewalk. Integral curb and sidewalk shall conform to the cross-section shown on the plans and shall be constructed in a similar manner to curbs specified herein. Sidewalk portion shall have a broomed finish.

3.3.07 Road Pavement Joints. All transverse joints in the concrete pavement shall extend entirely through the integral curb. The edges of the transverse joint in the curb shall be rounded with an approved finishing tool having a radius of 1/4 inch (6.4 mm).

Joints in the integral curb shall be sealed with Hot-Poured Rubber-Asphalt type compound as specified in Section 8.16 of the MDOT Standard Specifications for Construction.

Transverse contraction joints per MDOT Road Standard Plan No. II-39K shall be placed at the locations shown on the plans and elsewhere at maximum intervals of 25 feet (7.6 m) between expansion joints. The minimum distance between any load transfer joints shall be 12.5 feet (3.8 m).

Expansion joints per MDOT Road Standard Plan No. II-39K, and expansion joints with load transfer assemblies shall be placed at locations shown on the plans and at locations as follows:

At the “spring lines” of street returns.

At the P.C. and P.T. of horizontal curves where the degree of curvature is 2 degrees 30 minutes or more. These joints may be omitted during the period from September 15th to April 15th, as directed by the Engineer.

Where necessary to relieve horizontal pressures at sharp vertical curves where shown on the plans or as directed by the Engineer.

During the period from September 15th to April 15th, expansion joints shall be spaced at maximum intervals of 315 feet (96.0 m), this includes a full-width expansion joint for any portion of multiple-lane pavement placed during this period.

End-of-pour-joints shall be placed at the location of full width pavement and the start of non-reinforced temporary transition tapers as shown in MDOT Road Standard Plan No. II-39K, or as directed by the Engineer.

3.3.08 Alley Pavement Joints. Expansion joints and contraction joints shall be constructed as shown on the plans.

All joints shall be constructed true to line with their face perpendicular to the surface of the pavement. Transverse joints shall be constructed at right angles to the center line of the pavement, unless otherwise required, and shall not vary more than 1/4 inch (6.4 mm) from a true line. Longitudinal joints shall be constructed parallel to the center line of the pavement, unless otherwise required, and shall not vary more than 1/4 inch (6.4 mm) from their true designated position.

The surface of the pavement adjacent to all joints shall be finished to a true surface. The surface across the joint shall be tested with 10 feet (3.1 meter) straightedge as the joints are finished, and any irregularities shall be corrected before the concrete has hardened.

Longitudinal Contraction joints shall be constructed in pavements 17 feet (5.2 m) or greater in width, unless otherwise directed by the Engineer.

Longitudinal Contraction joints shall be constructed 6 inches (15.2 cm) from and parallel to the center line by cutting with a saw, to a minimum depth of 2 inches (5.1 cm) after the concrete has hardened sufficiently to permit sawing without damage to the pavement. The joint shall be cut within 24 hours after the concrete has been poured. The sawed joint shall be immediately flushed out with a jet of water.

Longitudinal Contraction joints shall be constructed 6 inches (15.2 cm) from the alley gutter on the high side of the pavement if the pavement is warped enough to shift the alley gutter from the center line of the pavement.

The concrete saw shall be adequately powered, self-propelled and constructed to cut hardened concrete rapidly with a water cooled diamond edge or abrasive saw blade to a depth of at least 2 1/2 inches (6.4 cm). The minimum width of saw blade shall be 3/16 inch (4.8 mm).

Transverse Contraction joints shall be constructed at locations shown on the plans. The premolded filler shall be placed in the concrete after rough finishing of the slab has been completed. The top edge of the premolded filler shall be placed with the top edge flush with the adjacent concrete surface. Concrete shall not bridge over the top of the premolded filler.

Construction joints shall be key joints, with provision for joint filler as shown on the Plans. Construction joints shall be placed at the ends of all pours and at places where paving operations are stopped for a period of more than 1/2 hour, except where such pours end at expansion joints. Construction joints shall be formed by placing a bulkhead.

Bulkheads for construction joints shall be of lumber not less than 2 inches (5.1 cm) nominal thickness, shaped to conform to the cross-section of the pavement.

One inch (2.5 cm) transverse expansion joints shall be located at all intersections and at locations shown on Plans. 1 1/2 inch (3.8 cm) expansion joints shall also be placed along the edge of pavement abutting building walls or other solid structures.

The bottom of the premolded filler shall be set 1 1/2 inches (3.8 cm) or more below the bottom of the slab. The premolded filler shall be set and held in a vertical position. The joint shall be free from concrete and the end of the joint cleaned of hardened concrete as soon as the forms are removed.

The premolded joint filler shall be furnished in lengths not less than the lane widths being poured, except that lengths greater than 12 feet (3.7 m) will not be required. Where more than one section is allowed and used in a joint, the sections shall be fastened together with a half lap scarf joint securely clipped together. The scarf shall have a minimum length of 3 inches (7.6 cm).

During installation, the joint filler shall be held securely in place. The top edge of the filler shall be protected, while the concrete is being placed.

Transverse expansion joints only shall be sealed.

Joints shall be filled and sealed in accordance with the same requirements as that for road pavement joints.

3.3.09 Concrete Base Course Joints. All joints shall conform to the details and position shown on the plans, with the following exceptions:

> Joints in Unreinforced Concrete Base Course: Sawed transverse contraction joints shall not be required.
>
> Joints in Reinforced Concrete Base Course: A load transfer unit shall not be required for transverse contraction joints. The pavement reinforcement shall be continuous through the joint.
>
> Joint Filler: Joints shall not be filled with poured joint filler. Premolded joint filler shall be placed with its top edge 1/2 inch (1.3 cm) below the pavement surface.

3.3.10 Reinforcement. Pavement reinforcement shall be placed as specified in Section 8.05 of the MDOT Standard Specifications for Construction, except that adjacent sheets or mats shall be lapped approximately 1 foot (30.1 cm) and that pavement reinforcement shall stop 6 inches (15.2 cm) from all expansion or contraction joints.

On the outside of 13.5 foot (4.1 m) lanes, pavement reinforcement for a 12 foot (3.7 m) lane shall be used with no reinforcement for the outside 1.5 feet (45.7 m) of pavement and curb.

Tie-bars shall be epoxy-coated. Damaged areas shall be repaired before placing concrete. Bent tie-bars shall be inspected after straightening, and any damaged epoxy coatings shall be repaired before embedment in concrete.

Expansion-anchored lane-ties shall be of the size and spacing shown on plans. They shall be either the self-drilling flush type, pre-drilled flush type, or the pre-drilled torque type. Expansion-anchored lane-ties shall replace broken bent lane tie-bars in longitudinal bulkhead joints at the Contractor's expense.

Load transfer assemblies used in 13.5 foot (4.1 m) lane widths shall be 11.5 feet (3.5 m) long. They shall be placed in the inside 12 feet (3.6 m) of the outside curb lane.

3.3.11 Placement. The concrete shall be distributed or spread as soon as placed. The concrete shall be deposited on the subgrade in such a manner as to require as little re-handling as possible. Any additional spreading required shall be done by means of shovels. The method and manner of placing shall be such as to avoid segregation and separation of the materials. The concrete shall be distributed to such depth and sufficiently above grade so that when consolidated and finished, the surface shall conform to the required finished grade. The concrete along the faces of the forms and adjacent to joints shall be consolidated and compacted to fill all voids and insure a dense smooth surface.

The depositing and spreading of the concrete shall be continuous, as far as possible, between transverse joints. In the case of a temporary shutdown, the concrete at the unfinished end of the slab shall be covered with wet burlap. In the event of an unavoidable interruption of the work continuing more than ½ hour, a construction joint shall be placed provided the section is 10 feet (3.1 m) or more in length between joints. Sections less than 10 feet (3.1 m) in length shall not be permitted, and if constructed shall be removed.

The entire area of the pavement shall be so consolidated as to ensure a minimum of voids. The concrete shall be struck off with a screed to the cross-section and thickness shown on the plans. The screed shall be set on side forms and upon a temporary center form or guide.

When constructing alley pavement, the temporary center form or guide shall be firmly staked or fastened to the exact line and grade of the alley gutter. This line and grade shall be produced to the center of the alley from the Engineer's stakes set at each grade change; intermediate points shall be accurately set by T-bars or other suitable methods.

Alley pavement edges shall be located in accordance with the plans and additionally warped as is necessary to meet adjacent garage entrances and existing pavements.

In all cases the minimum thickness of the pavement shall be the thickness shown on the plans.

Cement mortar gathered from the surface of the concrete already placed shall not be used for filling boot tracks or stony areas. Such areas shall be dug out, refilled with concrete, and worked smooth.

After striking off, the surface shall be finished to a gritty texture by means of a wooden float. If a metal float is used for final finishing, no more than two passes may be made over the surface.

3.3.12 Texturing of Concrete Pavement. Texturing of Concrete pavement shall be in accordance with Subsection 4.50.14 of the MDOT Standard Specifications for Construction, except as follows:

> As soon as the concrete has set sufficiently to maintain a texture, the concrete surface shall be dragged longitudinally with a stiff fiber artificial grass carpet.
>
> Under unusual conditions, the following texturing method may be utilized, if approved by the Engineer:
>
> As soon as all excess moisture has disappeared and while it is still possible to produce a uniform surface of gritty texture, the pavement surface shall be dragged longitudinally using a Monsanto Astroturf Mat, or approved equal, to a degree of texturing as directed by the Engineer. The astroturf mat shall be suspended from a movable bridge and shall be in full longitudinal contact with the pavement surface for a minimum distance of 3 feet (91.4 cm). This method of texturing shall apply to concrete pavement only, not to concrete base course.

The texturing mat shall be kept free from accumulations of concrete mortar by removing the mat from the movable bridge and flushing the mat with water, or by other means approved by the Engineer. The texturing mat shall be replaced when the mortar accumulations harden and cannot be removed.

3.3.13 Sawing Joints. Joints shall be sawed in accordance with the details shown on the plans and in accordance with Section 4.50.17 of the current MDOT Standard Specifications for Construction.

3.3.14 Texturing (Finishing). When the water sheen has practically disappeared, the pavement surface shall be textured (finished) by use of an approved broom or brush. The texturing operations shall produce uniform corrugations approximately 1/16 inch

(1.6 mm) in depth and approximately at right angles to the centerline of the pavement. Texturing shall be completed before the concrete is in such condition that the surface will be torn or unduly roughened by the operations. The finished surface shall be free from rough or porous areas, irregularities and depressions resulting from texturing operations and shall meet the approval of the Engineer. Brooms or brushes for texturing the pavement surface shall be of such material and design that they will be capable of producing uniform corrugations of the specified depth.

Final surface finishing of concrete base courses shall be as specified above except the pavement shall be rough broom finished.

3.3.15 Alley Pavement Stamp. The Contractor's name and the month, day and year in which the pavement was laid shall be carefully and clearly impressed in the concrete surface of each end slab, as directed by the Engineer.

The stamp or plate used for the marking shall have an approximate maximum outside dimension of 4 x 6 inches (10.2 x 15.2 cm). The Contractor's name and the current year's date shall be in such characters and arrangement that a legible and indelible impression may be made in the concrete.

3.3.16 Form Removal. Pavement forms shall not be removed from freshly placed concrete until it has set for at least 24 hours. After the form pins have been removed, the forms shall be carefully removed so that no damage will be done to the edge of the pavement.

After the forms have been removed, the ends of all concrete joints shall be cleaned and all honeycombed areas pointed. Such honeycombed areas shall be covered with wetted burlap until the pointing has been completed, after which the area shall be cured as specified below.

3.3.17 Patching of Transverse and Longitudinal Joints. The patching of transverse and longitudinal joints shall conform to the specific requirements of the MDOT, Standard Specifications for Construction on concrete pavement construction (Sections 4.50 and 4.52).

3.3.18 Protection. Fresh concrete pavement and integral curb shall be protected from rain and freezing, and the Contractor shall make this possible by keeping available sufficient covering material. The exposed surface of the concrete shall be protected from premature drying for a period of seven days after pouring.

Sufficient barricades and lights shall be provided to prevent traffic upon the concrete pavement for seven (7) days or for three (3) days if high-early strength concrete was used, unless such interval shall be modified when deemed necessary by the Engineer.

3.3.19 Curing. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the slab shall be completely coated and sealed with a uniform layer of membrane curing compound in accordance with Section 4.50.16 of the current MDOT Standard Specifications for Construction and as specified herein. The compound shall be thoroughly stirred to a uniform consistency in the drum just prior to transfer of the compound to the membrane spraying equipment. Curing compound shall not be thinned.

The curing compound shall be applied at a minimum rate of 1 gallon per 200 square feet (1 liter per 4.9 square meters) of surface. For miscellaneous concrete pavement over one lane in width, where a manually operated pressure-type sprayer is used, the compound shall be applied from a foot bridge. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply a new coat of material to the affected areas equal in curing value to that specified for the original coat.

Curing of concrete base courses shall be as specified above except that transparent membrane curing compound shall be used.

All traffic, either foot or otherwise, will be considered as injurious to the film of the applied compound. A minimum of foot traffic will be permitted on the dried film as necessary to properly carry on the work, such as sawing joints, provided any damage to the film is immediately repaired by another application of compound. If fixed-forms are removed during the curing period, the entire area of the sides of the slab shall be coated with curing compound immediately after removal of the forms. Approved hand-spray equipment will be permitted for the application of the curing compound on the sides of the slab and for repairing damaged areas.

Failure to provide proper curing will be considered as sufficient cause for immediate suspension of the concreting operations.

When approved by the Engineer, curing compound may be omitted when cold-weather protection is used during the curing period.

3.3.20 Cold-weather Protection. No concrete shall be placed after November 1, and prior to May 1, without specific written authorization of the Engineer. Without exception, all costs associated with placing concrete in cold weather shall be the responsibility of the Contractor.

If the authorization is given to place concrete during this period and the use of high-early strength concrete was not originally specified, the Engineer may require the use of high-early strength concrete at no extra cost. In any case, concrete shall be adequately protected when necessary from cold weather and freezing and precautions taken to prevent any damage to the concrete from low temperatures.

Frozen concrete or concrete otherwise damaged from cold weather shall be removed and replaced with sound concrete at the Contractor's expense. When low air temperatures are probable, a plan and method for protecting the concrete during its early stages shall be adopted, subject to the approval of the Engineer and in conformity with the limiting requirements herein. Only such methods shall be used that will maintain reasonably uniform temperatures and provide proper moisture conditions for curing. All required materials, special equipment and facilities needed to provide the adequate provisions shall be readily available before the low temperature actually occurs.

The subgrade shall not be frozen when pouring concrete. When necessary to excavate below subgrade to remove frozen material, the excavated space below the subgrade shall be refilled with unfrozen crushed stone, gravel or sand, but not with clay or loam. If such suitable materials are not available for backfill, then concrete shall be used for the full depth of the excavation.

Whenever it is anticipated that the air temperature at the point of concrete placement is likely to be 40 degrees F (4.4 degrees C) or lower during the 24-hour period following the pouring, or below 30 degrees F (-1.1 degrees C) during the succeeding seven days, protective measures shall be taken.

At times when prevailing air temperatures will produce concrete of less than 65 degrees F (18.3 degrees C), mixing water shall be heated. Concrete materials entering the mixture shall be free of lumps, frost, snow, or ice. When necessary, the concrete materials shall also be heated so as to produce a concrete having a temperature of not less than 65 degrees F (18.3 degrees C), nor more than 90 degrees F (32.2 degrees C) and as near 70 degrees F (21.1 degrees C) as possible at the time of pouring. The heating of the materials shall be done in a manner and by such methods as will keep the materials clean and free from injurious substances. The heating of the mixing water and aggregates shall be controlled so that there will be no large differences in temperature form batch to batch. The maximum temperature for the heated water and fine aggregate shall not exceed 150 degrees F (65.6 degrees C), and that of the heated coarse aggregate shall not exceed 100 degrees F (37.8 degrees C). Salt or other chemicals shall not be added to prevent freezing.

Calcium chloride shall be added to concrete mixture to accelerate the hardening of the concrete under conditions stipulated below. The calcium chloride shall be added to the concrete mixture only in solution in water and not in dry flake form. The maximum amount of calcium chloride that may be added is 2 percent of the weight of the cement in the batch, or slightly less than 2 pounds (0.9 kilograms) per standard sack of cement.

The solution shall be made up on the basis of 4 pounds of flake calcium chloride in 1 gallon (0.48 kilograms in 1 liter) of hot water of hot water. The solution shall be considered as part of the total allowed concrete mixing water, unless authorized by the Engineer. Thus, if a 1 percent calcium chloride mix is needed, 1 quart (0.95 liters) of the solution is added per bag of cement. If a 2 percent calcium chloride is needed, then 2 quarts (1.9 liters) of solution is added per bag of cement.

Concrete which will be deposited when the predicted air temperature is in a range listed below, shall be prepared in accordance with the provision stipulated for the applicable range.

> 40 degrees to 30 degrees F (4.4 degrees C to –1 degrees C): 1 percent calcium chloride added to concrete mix.
>
> 28 degrees F (-2.2 degrees C) and rising: 1 percent calcium chloride added to concrete mix and heated mixing water used.
>
> 35 degrees F (1.7 degrees C) and rising: Either or both of above requirements may be omitted.
>
> 40 degrees F (4.4 degrees C) or lower before dark: 1 percent calcium chloride added to concrete mix for concrete that will be poured after 1:00 p.m., to accelerate setting to allow completion of finishing operations and covering within daylight hours.

Concrete when being placed shall have a temperature within the range specified. Forms shall be free of ice, snow and frost at the time of pouring concrete and the subgrade shall not be frozen. The poured concrete shall be protected as shown in the tables below:

Table 1 - Minimum Temperatures & Durations for Concrete Curing (Normal Strength)

Section Thickness	Minimum Temperature (°F)	Period of Time (Days) That Minimum Temperature Is Required
Thin	55	2
Moderate	50	2
Massive	45	2

Notes:
1) If concrete has any exposure to freeze-thaw cycle, add 1 day.
2) If concrete is high early strength concrete, subtract 1 day.

Table 2 – Maximum Allowable Rate of Cooling Once Temperature Protection is Removed

Section Thickness	Maximum Allowable Temperature Drop (°F) In Any 1 Hour	Maximum Allowable Temperature Drop (°F) In First 24 Hours
Thin	5	50
Moderate	4	40
Massive	3	30

Marsh hay or straw shall be used for a protective covering unless another equally effective means is approved by the Engineer. Where necessary to maintain the required minimum temperatures, the hay or straw shall be covered with tarpaulins, or other approved materials, securely weighted against displacement by wind.

A high-low thermometer shall be furnished and installed as directed by the Engineer to record the maximum and minimum temperature of the concrete.
Periodic inspections shall be made to assure the protective covering is properly maintained in place. Any concrete damaged by freezing or overheating shall be removed and replaced with sound concrete at the Contractor's expense.

3.3.21 Alley Barricades. Temporary alley barricades shall be constructed and placed as detailed on the drawings.

The Barricades shall be promptly removed and the pavement opened to traffic when so directed by the Engineer, which generally will be upon the expiration of the curing period.

3.3.22 Backfilling. After the concrete has gained sufficient strength, the remaining excavated areas shall be backfilled with approved material, compacted thoroughly, and left in a neat condition. Provide suitable backfill as specified herein if excavated material is insufficient in quantity or unsuitable for backfill.

Compaction shall be to at least 95 percent of the maximum unit weight.

3.3.23 Cleaning. Any concrete spilled on the pavement or structures shall be removed and the pavement or structures thoroughly cleaned before the concrete sets. Spilled concrete shall not be washed into sewers or drains. The site of the work shall be restored to a neat and clean appearance, including the removal of excess earth, material, forms and equipment.

3.4 FIELD QUALITY CONTROL. Before final acceptance of the pavement, cores will be taken from the pavement after placement to determine the compressive strength at 28 days, the thickness of the pavement, and the depth of pavement reinforcement below the pavement surface. The Contractor shall be required to hire a testing laboratory, to perform testing of the installed concrete pavement.

The frequency of coring will be based on pavement units. The width of a unit is a lane. The width of each lane is determined by mandatory and/or optional joints indicated on the cross sections shown on the plans, except that thickened edges of lanes will not be included in the lane widths. The length of a unit will be 250 linear feet (76.2 linear meters) or any fraction thereof.

3.4.01 Coring the Pavement. An initial 6 inch (15.2 cm) core shall be taken from each prescribed unit through the entire thickness of the pavement at such times and locations as directed by the Engineer. The cores shall be drilled and handled in accordance with ASTM C42.

3.4.02 Measuring and Testing the Core. Each core shall be measured for thickness of concrete and depth of steel reinforcement and tested for compressive strength at 28 days after placement.

The measurement for length of core, depth of reinforcement, and the averaging of measurements when more than one core is taken form a unit, will be reported to the nearest 0.1 inch (3 mm) in accordance with the Rounding-Off Method of ASTM E29.

3.4.03 Measurement for Thickness of Pavement. The length of a core for determining pavement thickness shall be determined by average measurements of the core in accordance with AASHTO T148.

When averaging core lengths, measurements which are in excess of specified pavement thickness by more than 0.2 inches (5.1 mm) will be considered as the specified thickness plus 0.2 inch (5.1 mm).

3.4.04 Measurement for Depth of Reinforcement. Measurements for depth of reinforcement will be made from the top surface of the core to the top of the longitudinal bar or wire. If a core does not include a section of pavement reinforcement, an additional core will be taken not less than 10 feet (3.1 m) nor more than 10 feet (3.1 m) ahead of the core. This additional core will be used for the determination of the depth of pavement reinforcement and not for the measurement of pavement thickness.

3.4.05 Determination of Compressive Strength. The compressive strength at 28 days after placing shall be determined according to ASTM C42.
The core shall be classified in accordance with the results or the measurements for concrete thickness, the depth of steel and the compressive strength in accordance with the ranges indicated in Tables I, and II.

The Engineer shall be furnished with a certified report of such measurements and tests. After making such measurements and tests, the cores shall be delivered to the Engineer for further checking and tests.

Table 3 - Classification of Cores for Pavement Deficient in Thickness

Core Type	Deficiency in Thickness Determined by Cores, Inches (mm)
A	0.2 (5 or less)
B	0.3 (6 to 9)
B	0.4 (10 to 12)
B	0.5 (13 to 15)
B	0.6 to 1.0 (16 to 26)
C	1.1 (27) and over

Table 4 - Classification of Cores for Reinforced Concrete Pavement where Reinforcement is out of Tolerance.

Depth Range of Reinforcement, inches (mm)

Core Type	Pavement Thickness		
	7 ½ - 8 ½ (190 – 219) inches (mm)	**8 ½ - 9 ¾ 220 – 249 inches (mm)**	**9 ¾ - 11 250 – 279 inches (mm)**
Z	0 – 1 (0 – 24)	0 – 1 (0 – 24)	0 – 1 (0 – 24)
X	1 – 2 (25 – 49)	1 – 2 (25 – 49)	1 – 2 1/4 (25 – 59)
W	2 – 4 (50 – 99)	2 – 4 ¼ (50 – 110)	2 1/4 – 5 ¼ (60 – 134)
X	4 – 5 (100 – 124)	4 1/4 – 5 1/2 (111 – 139)	5 1/4 – 6 ¼ (135 – 159)
Y	5 – 6 (125 – 152)	5 1/2 - 7 1/4 (140 – 184)	6 1/4 – 8 ¼ (160 – 209)
Z	6 & over (165 & over)	7 1/4 & over (185 & over)	8 1/4 & over (210 & over)

* When a core length measures 1/10 inch (3 mm) or more over the plan thickness, the maximum depth range will be increased by 1/2 of the excess core length over the plan thickness. For each core, the increase will be rounded off to the nearest 1 mm in accordance with rounding-off method of ASTM E29 and then added to the range shown.

3.4.06 Additional Coring Requirements for Pavement Deficiencies. When the initial core from a pavement unit is classified as Type AW, no additional cores will be taken from that pavement unit.

When the initial core from a pavement unit is classified as other than Type AW, additional cores will be taken. The additional cores will be measured only for the defect that required the taking of the additional cores. Additional coring requirements for the various core types will be as follows:

When core measurements indicate the core to be one of Types AX, AY, BW, BX, and BY, two additional cores will be taken within the pavement unit. When the coring is being done on a linear foot (meter) basis, one additional core will be taken not less than 10 feet (3.1 m) nor more than 300 feet (91.4 m) in each direction from the initial core.

If the measurements of the 2 additional cores lie within the Type AW, AX, AY, BW, BX or BY range, no further cores will be taken within this pavement unit. Any adjustment to the contract price will be in accordance with the General Conditions.

When core measurements indicate the core to be one of Types AZ, BZ, CW, CX, CY, and CZ, additional cores will be taken randomly within the pavement unit but spaced at 10 foot (3.1 meter) longitudinal intervals in each direction from the initial C and/or Z core until, in each direction, a core is obtained which is no longer in a C and/or Z range. The second core so obtained which is not in a C and/or Z range will be used only for determining the extent of the area having a deficiency in the C and/or Z range. The procedure to be followed after the first core is obtained will be dependent on the classification of the core, with any adjustment to the contract price in accordance with the General Conditions.

3.4.07 Adjustment for Substandard Concrete. The applicable portions of the contract price as a total shall be decreased for substandard concrete pavement based on Table 3 and 4 above. The amount of adjustment and correction actions required shall be as shown in Table 5 below or as defined by the governing authority for the concrete pavement being poured.

Table 5 - Contract Decreases

If core is classified as shown below	Or classified as shown below,	Then all portions of the contract related to concrete paving as a total shall be reduced by the percent show below.	In addition, the following corrective actions will be taken.
Core Type From Table 3	**Core Type From Table 4**	**Percent Contract Decrease**	**Required Corrective Action**
A	W	0 %	
B		5 %	
C		15 %	
D	X	25 %	
E	Y	50 %	
F	Z	100 %	Remove & Replace

End of Section

SECTION 02755

REMOVAL AND REPLACEMENT OF CURBS AND SIDEWALKS

PART 1 – GENERAL

1.1 SCOPE**.** This section covers removal and replacement of concrete curbs and sidewalks including all necessary incidental work such as grading, subgrade preparation, forms, joints, finishing, and curing.

1.2 GENERAL. At the Contractor's option, concrete curbs may be constructed by conventional forming and placing methods or by means of an acceptable slip form process.

1.2.01 Governing Standards.

AASHTO M33 as Revised, Preformed Expansion Joint Filler for Concrete Bituminous Type).

AASHTO T26 as Revised - Standard Method of Test for Quality of Water to be Used in Concrete.

AASHTO T96 as Revised - Resistance to Abrasion of Small Size Course Aggregate by use of the Los Angeles Machine.

AASHTO M213 as Revised - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Type).

ASTM (American Society of Testing Materials) A185 – Steel Welded Wire Fabric Plain for Concrete Reinforcement.

ASTM A497 – Welded Steel Wire Fabric Deformed, for Concrete Reinforcement.

ASTM A615/A615M – Deformed and Plain Billet-Steel for Concrete Reinforcement.

ASTM C31/C31M – Practice for Making and Curing Concrete Test Specimens in the Field.

ASTM C33 – Concrete Aggregates.

ASTM C39-C39M – Test Method for Compressive Strength of Cylindrical Concrete Specimens.

ASTM C42/C42M – Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

ASTM C94/C94M – Ready-Mixed Concrete.

ASTM C136 – Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM C143/C143M – Test Method for Slump of Hydraulic Cement Concrete.

ASTM C150 – Portland Cement.

ASTM C172 – Practice for Sampling Freshly Mixed Concrete.

ASTM C173 – Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

ASTM C174/C174M – Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.

ASTM C231 – Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

ASTM C260 – Air-Entraining Admixtures for Concrete.

ASTM C309 – Liquid Membrane-Forming Compounds for Curing Concrete.

ASTM C494 – Chemical Admixtures for Concrete.

ASTM C595 – Blended Hydraulic Cements.

ASTM C666 – Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

ASTM D98 – Calcium Chloride.

ASTM D1751 – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

ASTM D1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

AASHTO (American Association of State Highway and Transportation Officials) M33 as Revised - Preformed Expansion Joint Filler for Concrete (Bituminous Type).

AASHTO T26 as Revised - Standard Method of Test for Quality of Water to be Used in Concrete.

AASHTO T96 as Revised - Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine.

AASHTO M213 as Revised - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

ACI 301 (American Concrete Institute) – Specifications for Structural Concrete for Buildings.

ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

Fed. Spec. SS-S-164 Sealing Compound; Hot Poured Type, for Joints in Concrete.

1.3 QUALITY ASSURANCE. Perform work in accordance with 1990 MDOT (Michigan Department of Transportation) Standard Specifications for Construction sections on Roadway Earthwork; Concrete Curb and Gutter; and Concrete Sidewalk, Sidewalk Ramps, and Steps and 6.11 and as specified in the standards of the County, City or Township having jurisdictional authority as well as the 1999 Standard Specifications for Paving and Related Construction for the City of Detroit. Replacement work shall match the appearance of the original construction.

Obtain cementitious materials form same source throughout.

1.4 SUBMITTALS.

1.4.01 Product Data. Three copies of the mix design shall be submitted to the Engineer. Submit data on joint filler admixtures and curing compounds.

1.4.02 Certification. Submit certification that concrete mix conforms to specified MDOT mixes. Submit mix design for approval for all non-MDOT concrete mixes.

PART 2 – PRODUCTS

2.1 MATERIALS. Concrete shall be composed of a mixture of Portland Cement, fine aggregates, coarse aggregates, fly ash, admixtures, when specified, and water.

2.1.01 Fill Materials. Earth materials excavated under this Contract, to be suitable for backfill behind the curb or integral curb and sidewalk, the filling of low places in a strip 2 feet (61 cm) wide and paralleling the constructed curb, and integral curb and sidewalk, shall be a type that may be thoroughly compacted by the method specified. Such material, to be useable, shall be free from rubbish or debris, vegetable matter, large stones, concrete fragments or other road material, lumber, tree roots, or branches. In general, select excavated material to be suitable for backfill shall be restricted to sand or crumbly clay, unless indicated otherwise on the drawings. Approved offsite fill of similar quality shall be provided when excavated material is of insufficient quantity or unsuitable for use as backfill.

2.1.02 Concrete Materials. The materials shall meet the requirements specified in the MDOT Standard Specifications for Construction.

Concrete, 30P, 35P, 35HE	Section 7.01
Mortar and Grout	Section 7.02
Steel Reinforcement	Section 8.05
Joint Materials	Section 8.16
Curing Materials	Section 8.24

For instances where an MDOT mix is not specified, provide concrete as follows. Grade “A” concrete shall be used throughout the work except that Grade “C” concrete may be used for backfills, unless stronger concrete is called for on the plans.

Grade “A” concrete shall have a minimum compressive strength of 4,000 psi (27.6 kPa) at 28 days and shall contain not less than 6 ½ sacks of cement per cubic yard (8 ½ sacks of cement per cubic meter) of concrete. Grade “C” concrete shall have not less than 3 sacks of cement per cubic yard (4 sacks of cement per cubic meter) of concrete.

2.1.03 Water. Water used in concrete or mortar mixtures or for curing concrete shall be potable or reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

2.1.04 Cement. Cement for use in concrete shall be “Portland Cement” conforming to the respective requirements of the applicable ASTM specification listed below. Cement of only one kind and type shall be used throughout the work and it shall be a standard brand of a single producer, unless otherwise specifically authorized by the Engineer.

Type I, IA, III and IIIA Portland cements shall conform to ASTM C150. The requirements for Gilmore Setting Time Test and compressive strength through the 28-day test shall apply.

2.1.05 Fine Aggregate (Sand). Fine aggregate shall be natural sand consisting of fine granular material resulting from the natural disintegration of rock or manufactured sand or a combination thereof. The sand shall consist of clean, sound, durable particles free from any adherent coating, clay lumps or other deleterious substances, and at the time of use shall be entirely free of frozen material.

Fine aggregate shall conform to the requirements of the current MDOT Standard Specifications for fine aggregates for Portland Cement concrete, natural sand, Type 2NS.

2.1.06 Coarse Aggregate. Coarse aggregate shall consist of gravel, stone, or slag all of which shall conform to the current MDOT Specifications for type 6AA. Coarse aggregate shall be used in all concrete permanently exposed to weather.

2.1.07 Admixtures. Admixtures include all materials other than water, aggregates, and Portland Cement that are used in the making of concrete and that are added to the batch immediately before or during the mixing.

Admixtures, other than Air-Entraining admixture conforming to the requirements of ASTM C260 shall not be used in the concrete without the prior written approval of the Engineer.

Admixtures that may be used with written approval of the Engineer are Calcium Chloride per ASTM D98, Type 1 regular flake and water reducing admixtures ASTM C494, Type A and Type D.

2.1.08 Joint Materials. Filler for expansion joints shall be premolded bituminous, ASTM D1751 unless indicated otherwise on the drawings. Filler for contraction joints shall be bituminous joint filler, AASHTO M33 unless indicated otherwise on the drawings. Filler for curb expansion and contraction joints shall be premolded bituminous, ASTM D1751 or AASHTO M213 Type III unless indicated otherwise on the drawings.

Poured joint filler shall be hot-poured rubber-type compound, Fed Spec. SS-S-164.

2.1.09 Forms. Pavement and curb forms shall be straight and free from distortion, and of sufficient strength to resist forces applied during the process of placing concrete against them. The forms shall be of an approved section, with a flat surface on top, and shall be of the full depth of the pavement or curb.

Forms for radius corners shall be steel or thin board, accurately formed to true radius, and held by bracing and stakes to maintain a true curve.

PART 3 – EXECUTION

3.1 PREPARATION.

3.1.01 Sidewalk Removal. The required removal shall be done in a manner that will avoid damage to property and any existing sidewalks and driveways that are to remain. Where portions of an existing sidewalk or driveway are to remain, the removed portion shall extend to an existing joint or sawed joint as directed by the Engineer. The sawed joint shall be cut full-depth with a power-driven concrete saw.

Earth removal at the edges of the existing sidewalks shall be limited to that reasonably required for the subsequent installation of the concrete forms or rails. Existing sod shall be carefully removed and suitably stored for later replacement. Such work will be considered incidental to the cost of construction.

3.1.02 Subgrade. Subgrade for sidewalks shall be compacted to a density equivalent to the density of the immediately surrounding undisturbed soil for a depth of 6 inches (15.24 cm).

3.1.03 Curb Removal. Existing curbs which are to be removed will be designated in the field by the Engineer. The required removal shall be done in a manner that will avoid damage to property and to any existing sidewalks that are to remain.

Where existing curb is located over a gas service line, the use of a drop-weight type pavement breaker, crane and ball type breaker, hydraulic ram, or breaker called a “Woodpecker” shall not be used for curb removal.

Separate type curb shall be completely removed, including existing concrete backing or fill, unless otherwise directed by the Engineer.

Curb removal for integral curb and sidewalk and modified separate type curb shall be done in accordance with the requirements shown on the standard plans.

Earth removal at the back of and adjacent to existing curbs shall be limited to that reasonably required for the subsequent concrete construction including the necessary form work.

3.1.04 Forms. Forms for curves shall be rigid steel forms except on returns or curved sections. Forms for sidewalks shall be steel, except that wood forms may be used on sharp turns and for special sections when approved by the Engineer. If forms for sidewalks are wood, the least dimension shall be nominally 2 inches (5.1

cm) and lumber shall be free of loose knots and knotholes. All side forms shall have a depth at least equal to the edge thickness of concrete being formed.

All forms shall be in good condition with no more than 1/8 inch (3.2 mm) variation in horizontal and vertical alignment for each 10 feet (3.1 m) in length. Forms shall be set true to line and grade and shall be adequately supported to stay in position while depositing and compacting concrete. Forms shall be designed and constructed so as to permit their removal without damage to concrete. The forms shall be oiled with a light clean paraffin oil which will not stain the concrete.

Slip forms for curbs will be permitted upon approval of the Engineer as to methods and equipment.

3.2 INSTALLATION. Curbs shall be constructed in the locations they are removed due to construction operations and shall match the shape of the curb that was removed and the adjacent construction. Expansion joints shall be placed at intervals not greater than 50 feet (15.24 m), at the beginning and end of all radii, and where the curbs abut structures. Contraction joints shall be provided at intervals not greater than 10 feet (3.1 m) and shall not be less than 2 inches (5.1 cm) deep. Tool marks shall not be left in the exposed portion of curbs.

If slip forming is used, an acceptable slip form curb machine shall be used to place, consolidate, and finish the freshly placed concrete in one complete pass in a manner that will require a minimum of hand finishing to produce a dense and homogenous section in conformance with the details indicated on the drawings. A form shall trail behind the machine for such a distance that no appreciable slumping of the concrete will occur. Final finishing shall be as specified hereinafter.

Concrete sidewalks shall be constructed in the locations they are removed due to construction operations and shall match the general characteristics of the removed and adjacent sections of sidewalk. Sidewalks shall be edged and grooved. Expansion joints shall be placed where sidewalks abut structures and curbs, and at intervals not greater than 50 feet (15.24 m).

3.2.01 Joints. Expansion joints in slip form construction shall be made by removing a portion of the freshly placed concrete, inserting 1/2 inch (1.3 cm) thick joint filler, and replacing hand finished concrete at the joint. Rigid forms shall be placed at these joints and left in place for a length of time sufficient to ensure that no appreciable slumping of the hand placed concrete will occur.

Expansion joints in sidewalks shall be formed 1/2 inch (1.3 cm) thick and shall extend the full depth of the slab. All of the joint except for the top 1/2 inch (1.3 cm) below the surface of the sidewalk slab shall be filled with expansion joint material. Sealer shall be poured into the joint to the level of adjacent concrete surfaces.

Contraction joints in curbs shall be placed every 10 feet (3.1 m) and at tangents to radii sections. Contraction joints in curbs shall be formed by 1/4 inch (6.4 mm) thick templates, cut to the configuration of the curb section to the extent indicated on the drawings. These templates shall be secured so that they do not move during placement and compaction of concrete.

As soon as concrete has sufficiently hardened, templates shall be removed from joints, and edges of the joint shall be rounded with an edging tool of 1/8 inch (3.2 mm) radius.

Contraction joints may also be constructed by sawing through curbs to a depth of not less than 1 1/4 (3.2 cm) inches below the surface and with a width of cut not to exceed 1/4 inch.

Contraction joints in sidewalks shall be located so as to provide square panels with a maximum dimension of 7 feet (2.13 m) or as indicated on the drawings. Joints shall be 1/8 inch wide by 1 inch (2.5 cm) deep and may be formed either by inserting a fiber strip, by tooling, or by cutting with a concrete saw.

3.2.02 <u>Finishing</u>. Each curb shall be tooled to the required radii as soon as possible after the concrete takes its initial set. After the forms and templates are removed, the joints shall be tooled and the surface finished with a wood or cork float to remove all imperfections without additional mortar or drier. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections and form stakes removed. No plastering of the concrete will be allowed. Each finished curb shall have a true surface; shall be free from sags, twists, or warps and shall have a uniform appearance. Final finishing shall be light brooming transverse to the line of the curb.

After concrete in sidewalks has been thoroughly consolidated and leveled, and the initial set has taken place, the surface shall be finished with a wood or cork float and either burlap or broom finish. The top surface of sidewalks shall be uniform in color and edges shall be tooled. Care shall be taken to ensure a straight, neat appearance along edges of the sidewalk and at joints.

3.2.03 <u>Curing</u>. After finishing operations have been completed and immediately after the free water has left the surface, the surface of the slab shall be completely coated and sealed with a uniform layer of membrane curing compound in accordance with section 4.50.16 of the 1990 MDOT Standard Specifications for Construction and as specified herein. The compound shall be thoroughly stirred to a uniform consistency in the drum just prior to transfer of the compound to the membrane spraying equipment. Curing compound shall not be thinned.

The curing compound shall be applied at a minimum rate of 1 gallon per 200 square feet (1 liter per 4.9 square meters) of surface. If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply a new coat of material to the affected areas equal in curing value to that specified for the original coat.

All traffic, either foot or otherwise, will be considered as injurious to the film of the applied compound. A minimum of foot traffic will be permitted on the dried film as necessary to properly carry on the work, such as sawing joints, provided any damage to the film is immediately repaired by another application of compound.

If fixed-forms are removed during the curing period, the entire area of the sides of the slab shall be coated with curing compound immediately after removal of the forms. Approved hand-spray equipment will be permitted for the application of the curing compound on the sides of the slab and for repairing damaged areas.

Failure to provide proper curing will be considered as sufficient cause for immediate suspension of the concreting operations.

When approved by the Engineer, curing compound may be omitted when cold-weather protection is used during the curing period.

3.2.04 Protection. The Contractor shall protect the concrete work against damage of any kind until it has been accepted by the Engineer. Concrete which has been damaged shall be removed and replaced or repaired by the Contractor to the satisfaction of the Engineer.

3.2.05 Restoration of Asphalt Surfaces. Any asphalt surface damaged during curb replacement work shall be replaced by saw cutting the pavement 1 foot (30.5 cm) from the face of the curb and parallel to it; and stripping the wearing course, and replacing with a wearing course mixture similar to the existing surface course with bond coat on the underlying base or leveling course.

End of Section

SECTION 02760

SIDEWALKS, SIDEWALK RAMPS AND DRIVEWAYS

PART 1 - GENERAL

1.1 SCOPE. This section includes the removal of existing and/or disintegrated concrete sidewalks and/or driveways, disposal of broken concrete and other waste materials, excavation, backfilling, and grading for sidewalks and driveway construction to the established grades and cross-sections, and protection of trees and trimming of tree roots, as required is included herein.

The furnishing, care, storage, and mixture of all materials which are necessary to be incorporated into the concrete, including contraction and expansion material; the furnishing, erection, stripping, care and maintenance of forms; the handling, transportation, and placement of concrete for the proposed sidewalks and driveways; and the protection and care of the partially completed and completed work until final acceptance.

1.2 GENERAL.

1.2.02 Governing Standards.

AASHTO (American Association of State Highway and Transportation Officials) M213, as revised – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).

ADA (American with Disabilities Act) – Standards for Accessible Design.

ASTM (American Society for Testing and Materials) A185 – Steel Welded Wire Fabric, Plain for Concrete Reinforcement.

ASTM A497 – Steel Welded Wire Fabric, Deformed for Concrete Reinforcement.

ASTM A615/A615M – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM C31/C31M – Practice for Making and Curing Concrete Test Specimens in the Field.

ASTM C33 – Concrete Aggregates.

ASTM C39/C39M – Test Method for Compressive Strength of Cylindrical Concrete Specimens.

ASTM C94/C94M – Ready-Mix Concrete.

ASTM C150 – Portland Cement.
ASTM C172 – Practice for Sampling Freshly Mixed Concrete.

ASTM C173 – Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

ASTM C174/C174M – Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.

ASTM C260 – Air-Entraining Admixtures for Concrete.

ASTM C309 – Liquid Membrane-Forming Compounds for Curing Concrete.

ASTM C494 – Chemical Admixtures for Concrete.

ASTM C595 – Blended Hydraulic Cements.

ASTM C666 – Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

ASTM D98 – Calcium Chloride.

ASTM D154 – Guide for Testing Varnishes.

ASTM D1751 – Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

ASTM D1752 – Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 QUALITY ASSURANCE. Perform work in accordance with MDOT (Michigan Department of Transportation) Standard Specifications for Construction Division of Earthwork and Miscellaneous Construction. Obtain materials from same source throughout period of construction.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit data on joint filler, admixtures, and curing compounds. Three copies of the mix design shall be submitted to the Engineer for review.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Maintain access for pedestrian and vehicular traffic during placement of curbs and sidewalks.

2.2 MATERIALS.

2.2.01 Concrete. Concrete shall be composed of a mixture of Portland Cement, fine and coarse aggregate, water and any admixtures used and blended together to produce a dense homogeneous finished material.

Water used in concrete or mortar mixtures or for curing concrete shall be potable and reasonably free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product.

2.2.02 Cement. Cement for pavement and curb concrete shall be "Portland Cement" conforming to the respective requirements of the applicable ASTM specifications. Cement of only one kind and type shall be used throughout the work and it shall be a standard brand of a single producer, unless otherwise specifically authorized in writing by the Engineer.

Type I, IA, III, and IIIA Portland Cements shall conform to ASTM C150. The requirements for Gillmore Setting Time Test and compressive strength though the 28-day test shall apply.

2.2.03 Fine Aggregate (Sand). Fine aggregate shall be natural sand consisting of fine granular material resulting from the natural disintegration of rock, manufactured sand, or a combination thereof. The sand shall consist of clean, sound, durable particles free from any adherent coating, clay lumps or other deleterious substances, and at the time of use shall be entirely free of frozen material.

Fine aggregate shall conform to the requirements of the current MDOT Specifications for Fine Aggregates for Portland Cement concrete, natural sand, Type 2NS.

Sampling and testing shall be done in accordance with methods and requirements in ASTM C33. Loss by washing shall not exceed 3%.

2.2.04 Coarse Aggregate. Coarse aggregate shall consist of gravel, stone or slag all of which shall conform to the current MDOT Specifications for Type 6AA, except for sampling and testing. Sampling and testing shall be done in accordance with the methods and requirements specified in ASTM C33. MDOT Serial No. 6AA coarse aggregate shall be used in all concrete permanently exposed to the weather.

2.2.05 Admixtures. Admixtures include all materials other than water, aggregates, and Portland cement that are used in the making of concrete and that are added to the batch immediately before or during the mixing.

Admixtures, other than air-entraining admixture conforming to the requirements of ASTM C260, shall not be used in the concrete without the prior written approval of the Contracting Engineer.

Admixtures that may be used with written approval of the Engineer are calcium chloride, ASTM D98, Type 1, regular flake and water reducing admixtures per ASTM C494, Type A and Type D. Neither Type A nor Type D admixtures shall contain calcium chloride.

2.2.06 Steel Reinforcement. Steel reinforcement for use in concrete sidewalks, sidewalk ramps, and driveways, shall conform to the specific requirements of the 1990 MDOT Standard Specifications for Construction on Steel Reinforcement, Section 8.05.

2.2.07 Joint Materials. Joint and joint filler materials for use in concrete pavements shall conform to the specific requirements of the MDOT Standard Specifications for Construction on Joint and Waterproofing Materials, Section 8.16.

2.2.08 Curing Materials. White membrane curing compound for curing concrete shall consist of pigments, a blend of oils and resins, and a volatile solvent and shall conform to the specific requirements of the MDOT Standard Specifications for Construction, Section 8.24 except, nonvolatile matter in the compound shall be not less than 40 percent by weight determined by methods for testing varnishes of ASTM D154. Also, the pigment shall not settle out excessively or cake in the container during storage and shall be capable of being mixed to a smooth, uniform consistency.

When curing compound containing linseed oil is called for in the documents or the proposal, the material shall comply with ASTM C309 or AASHTO M148. Application shall be as per manufacturer's recommendations and as directed by the Engineer.

PART 3 – EXECUTION

3.1 PREPARATION. Finished grades, alignments and contours shall be established, set, achieved and maintained to the satisfaction, and approval of the Engineer, prior to placing concrete.

3.1.01 Sidewalk and Driveway Removal. The required removal shall be done in a manner that will avoid damage to property and any existing sidewalks and driveways that are to remain. Where portions of an existing sidewalk or driveway are to remain, the removed portion shall extend to an existing joint or sawed joint unless otherwise directed by the Engineer. The concrete shall be cut full depth with a concrete saw. Adjacent to structures that are to remain in place, the removal procedures used shall be such that no damage occurs to the structure. In all instances, sufficient removal shall be made to provide for proper grades and connections between the old and new work.

Earth removal at the edges of the existing sidewalks and driveways shall be limited to that reasonably required for the subsequent installation of the concrete forms or rails. Earth which may be removed when removing concrete shall be replaced with a similar material at the contractor's expense. Existing sod shall be carefully removed and suitably stored for later replacement.

The exposed soil shall be prepared as a foundation for the new concrete replacement as specified herein.

3.1.02 Subgrade and Subbase Preparation. Excavation for sidewalk and driveway paving is limited to the width of the sidewalk or driveway plus 6 inches (15.2 cm) allowed on each side for forming. Additional excavation, unless directed by the Engineer, shall be backfilled, compacted, and landscaped at no additional cost. Excavation and shaping shall be to the required line, grade, and cross-section as shown on the drawings, and as indicated by stakes set on the site by the Engineer.

Vegetable matter at the subgrade shall be removed as directed by the Engineer, and the resulting space backfilled with suitable material and compacted in a manner specified herein.

Should the soil at the subgrade be, in the judgement of the Engineer, unsuitable as a foundation for the pavement, the excavation shall be taken down to firm soil as directed by the Engineer. The resulting space shall be backfilled with, and compacted as described above.

Excavation below the subgrade, unless directed by the Engineer, will be deemed unauthorized and the space of such excess excavation shall be backfilled in the same manner as specified above but at no additional cost.

The excavated subgrade area shall be uniformly compacted. A pneumatic or vibratory type mechanical tamper shall be used. The subgrade shall be so tamped as to closely approximate the required grade and cross-section.

Where the subgrade is at the required elevation, not requiring a subbase, the tamped and partially formed subgrade shall be trimmed and smoothed to the grade and cross-section required by the concrete construction, by a suitable method approved by the Engineer.

A subbase, when required, shall be placed on the tamped subgrade, as specified below.

The subgrade, or subbase where used, shall be moist, but not muddy, soft, or frozen, at the time of concrete placement. When necessary, the area shall be uniformly wetted by a method that will prevent forming pools of water.

Immediately prior to concrete placement, the prepared subgrade and subbase when used, shall again be tested for conformity with the required grade and cross-section, using an approved scratch template on the side forms or rails. Material shall be removed, or added and tamped, if and as required, to bring all portions of the exposed surfaces to the required elevations. The surfaces shall again be checked with the template. All loose material which may have fallen on the prepared surfaces shall be carefully removed.

The prepared subgrade and subbase shall be approved by the Engineer before any concrete is placed thereon.

The subbase wherever required on the subgrade shall be composed of MDOT Class II granular, fill material, except as hereinafter specified. The fill material shall be deposited and spread in not more than 8-inch (20.3 cm) layers loose measure, or as otherwise directed by the Engineer. Each layer shall be compacted in a similar manner to that specified above for the subgrade. The subbase shall be brought up to the grade required for the concrete construction. The final surface finish of the subbase shall be as specified above for subgrade.

Where the top of the concrete sidewalk or driveway will be above the original ground, the subbase fill shall be brought up to the top of the concrete and extend out level at least 12 inches (30.5 cm) from the edge of the concrete. From such

outside point, the fill shall extend to natural grade on a maximum slope of 1 ½ horizontal to 1 vertical.

Where necessary to provide for natural surface drainage, and when so directed by the Engineer, subbase shall be composed of MDOT 22A fill material, deposited, spread, and compacted in the same manner as specified for Class II fill material.

3.1.03 Tree Protection. Trees shall be protected from damage by the construction operations. The sidewalk adjacent to a tree shall, where necessary and when directed by the Engineer, be arced to provide an 18 inch (45.7 cm) clearance between the edge of the sidewalk and the tree trunk or root system at ground level. Such arcs shall be as uniform and symmetrical in appearance as is practicable to meet existing conditions.

Tree roots 3 inches (7.6 cm) and larger in diameter within the sidewalk or driveway area shall not be completely severed when they may be trimmed and still not protrude. Smaller roots which would protrude into the new concrete entirely or in part shall be completely removed. Cutting of tree roots 3 inches (7.6 cm) and larger in diameter shall be done under the supervision of the Engineer.

Tree Removal. Trees and stumps shall be removed as specified in the most current edition of MDOT Standard Specifications for Construction.

3.2 INSTALLATION.

3.2.01 Application. All sidewalks, whether repaired, replaced, or entirely new, shall ordinarily be constructed with a cross slope of 3/8 inches each foot (3.1 cm per meter) upward from the top of the pavement curb, or from the established grade therefore, towards the property line. The edge of the sidewalk at the curb side shall not exceed 6 inches (15.2 cm) as a maximum height above the top of the curb or above the established grade of the street. At intersection of streets, junctions with existing work, and other special conditions where it is not practical and reasonable to follow such cross slope, the sidewalks shall be constructed as directed by the Engineer.

Driveways across public property shall be constructed to the grades established by the Engineer. On unpaved streets, the Engineer will establish the line and grade.

All site preparation shall be so performed that the finished concrete sidewalks and driveways will conform to these requirements.

3.2.02 Erection. Concrete forms shall be suitably constructed, placed, positioned, secured and braced to achieve and maintain the established finished grades and contours, and to maintain position of all reinforcing, and expansion joint material, all to the satisfaction and approval of the Engineer.

Steel bar and wire reinforcing with appropriate chairs shall be provided, suitably placed, positioned and secured, all to the satisfaction and approval of the Engineer.

3.2.03 Placement. The base shall be moist and the mixed concrete shall be deposited thereon, to the depth specified on the Plans or in the Proposal, in successive batches and continuous operation without the use of bulkheads between joints. Regardless of the methods of mixing, transporting, placing and working, the concrete when deposited in the forms shall be free from segregation, have a slump of between 3 to 5 inches (7.6 cm to 12.7 cm) and contain not less than 4 percent nor more than 7 percent of entrained air.

The concrete shall be placed and distributed to such depth and sufficiently above grade that when consolidated and finished, the concrete surface will conform to the required finished grade and elevations. All spreading required shall be done with shovels. The concrete shall be thoroughly spaded along the face of the forms and adjacent to joints before finishing operations are started.

The concrete shall be struck off to the required grade and cross-section.

Sidewalk ramp slopes shall be uniform except as necessary for short grade changes.

Where gutters are replaced in conjunction with sidewalk ramps, the gutter shall be constructed to the same dimensions and profile and contain the same reinforcement as the existing gutter, unless otherwise shown on the plans.

3.2.04 Jointing. All concrete sidewalks and driveways shall have expansion joints and contraction joints in accordance with these specifications.

Joints shall be constructed true to line with their faces perpendicular to the surface of the sidewalk and shall not vary more than ¼ inch (6.4 mm) from their designated position.

When the sidewalk is constructed in partial width slabs, transverse joints in the succeeding slab shall be placed in line with the like joints in the adjacent slab. In the case of widening existing sidewalks, transverse joints shall be placed in line with joints in the existing sidewalk.

The concrete at the faces of all joints shall be thoroughly spaded or vibrated and compacted to fill all voids, and the surface shall be finished smooth and substantially true to grade.

Expansion joints shall be placed at right angles to the rail forms and perpendicular to the subgrade, and shall extend from 1 inch (2.5 cm) below the bottom of the pavement to the top of and flush with the finished concrete surface.

When a driveway apron abuts an existing private driveway or a sidewalk abuts a driveway the expansion joint filler shall extend 1 inch (2.5 cm) below the bottom of the thinner pavement.

Sidewalks less than 7 feet (2.1 m) in width shall have transverse expansion joints ½ inch (1.3 cm) in thickness at lot lines, except:

> Where individual lots are 25 feet (7.6 m) or less in width, an expansion joint shall be placed at every two lots on the lot line, and a divider joint shall be placed at the intervening lot line.
>
> Where individual lots are 50 feet (15.2 m) in width, additional expansion joints shall be so spaced so that in no case will joints be more than 50 feet (15.2 m) apart.

Driveways and full-width walks extending more than 7 feet (2.1 m) from the curb to the property or building line, shall have expansion joints 1 inch (2.5 cm) in thickness at both the curb and property or building line, or shall be divided at two or more places by expansion joints where:

The distance exceeds 30 feet (9.1 m).

The joints cannot be placed vertically at the curb or building line.

Driveway aprons shall have expansion or contraction joints so placed that no slab shall have nominal dimension exceeding 15 feet x 15 feet (4.6 m x 4.6 m).

Commercial driveways shall be divided on all sides by 1 inch (2.5 cm) thick expansion joints. Where commercial driveway aprons exceed 20 feet (6.1 m) parallel to the curb construction, contraction joints shall be placed at the center line.

All key flags or property line margin flags, driveways, crosswalks, junction of curb circles, and alley returns shall have 1 inch (2.5 cm) thick expansion joints.

Where hydrants are located within the sidewalk area, a 3 foot (91.4 cm) knockout square, centered on the hydrant, shall be constructed with full depth ½ inch (1.3 cm) expansion paper and 30 pound (13.6 kg) felt paper shall be wrapped around the hydrant at contact with the concrete.

Where utility poles are located within the sidewalk area, full depth, ½ inch (1.3 cm) expansion paper shall be required around the pole and, in addition, at the perimeter of a 3 foot (91.4 cm) knockout square centered on the pole.

Contraction joints shall be placed at intervals of not less than 5 feet (1.5 m) nor more than 7 feet (2.1 m) at right angles to the rail forms and perpendicular to the subgrade, and extending from the surface not less than one half the slab thickness. Walks 4 feet (1.2 m) in width shall have joints placed at intervals of not less than 4 feet (1.2 m) nor more than 7 feet (2.1 m). All walks extending to property or building line shall be a longitudinal joint at the margin line.

Contraction joints may be constructed by the use of either divider plates, premolded joint paper, or a jointer, with 1 1/2 inches (3.81 cm) minimum depth, or by sawing concrete when approved by the Engineer.

Divider plates shall be ¼ inch (6.4 mm) in thickness. Divider plates shall be removed after the concrete has set sufficiently to prevent slumping. After the divider is removed, the open joint shall be finished with a double edger, as specified under "Finishing."

Premolded joint filler paper shall be ¼ inch (6.4 mm) in thickness. The paper shall permanently remain in place. The surface of the concrete shall be finished with an edger on both sides of the paper, as specified under “Finishing.”

Sawed contraction joints may be used in lieu of the above methods upon specific authorization of the Engineer based upon methods and equipment proposed by the Contractor.

3.2.05 Finishing. As soon as free mortar appears on the placed concrete, a straight edge template shall be used as a strike-off across the rail forms to produce a true surface. While the concrete is still plastic, the surface shall be finished with wood or steel floats, bringing the surface to the required grade and cross-section. Care shall be taken not to overwork the concrete and bring an excess of water to the surface. Neat cement shall not be used as a dryer to facilitate finishing the surface.

When the concrete is sufficiently hard, the surface shall be carefully and uniformly scored by brooming with a brush having fine bristles, or by means giving

comparable results when approved by the Engineer. The surface of sidewalk ramps shall be textured with a coarse broom transversely to the ramp slope.

The edges of the concrete areas shall be rounded with approved finished tools having a radius not exceeding ¼ inch (6.4 mm). Such edging shall be carefully done so as to produce an evenly rounded edge, true to both line and grade.

3.2.06 Contractor’s Stamp. The Contractor’s name and the year in which the walk or drive was laid shall be carefully and clearly impressed in the concrete surface of each isolated flag, each flag at the property line, and in each end flag or slab of two or more adjoining flags or slabs. Each individual flag adjacent to a tree, whether arced or not, shall be also marked, as directed by the Engineer.

The stamp or plate used for marking shall have an approximate maximum dimension 4 x 6 inches (10.2 x 15.20 cm), outside dimension. The Contractor’s name and the current year’s date shall be in such characters and arrangement that legible and indelible impressions may be made in the concrete.

3.2.07 Protection of Concrete. The placed concrete shall be protected from damage from all causes. Sufficient covering material shall be kept available to protect the fresh concrete from pitting and washing in case of rain. No one shall be allowed to walk on or otherwise disturb the concrete until it has thoroughly set. Barricades and lights shall be provided to prevent traffic upon the concrete until it sufficient strength to avoid damage.

Barricades and lights shall not be removed from commercial drives until the concrete has developed 7-day strength.

Concrete shall be protected by suitable means from low temperatures and moisture from start of placement until completion of curing or until concrete has attained strength of at least 750 psi (5,171 KPa).

Any settlement, damage, or defects occurring in any portion of the work shall be repaired or that portion of the work replaced, as directed by the Engineer, prior to and as a condition of final acceptance.

3.2.08 Curing Concrete. All exposed concrete surface shall be protected from premature drying. Such surfaces shall be given an application of membrane curing compound immediately after the water sheen, which follows the final finishing, has disappeared. The compound shall be applied to concrete surface that is thoroughly wet but having no free water. The compound shall be applied as a spray at the rate of 1 gallon per 200 square feet (1 liter per 4.9 square meters) of surface. Buildings and property adjacent to the area being sprayed shall be protected from splashing or blowing of the curing compound.

The membrane curing compound shall be white pigmented. Transparent compound may be used at locations approved by the Engineer. Approval to use transparent curing compound shall be requested prior to placement of concrete.

The treated surfaces shall be protected from damage for at least seven days. Any area where the compound film is damaged in any way shall have a new coat of material applied in the same manner and rate as required for the original coat.

End of Section

SECTION 02820

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SCOPE. Section includes all labor, material, and equipment to construct fence framework, fabric, and accessories; excavation for post bases; concrete foundation for posts, and center drop for gates; and manual gates and related hardware.

Fencing shall be provided in the alignment and at the heights indicated on the drawings. Fencing shall have a top rail, bottom tension wire, and three strands of barbed wire projecting outward at the top.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

ASTM A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

ASTM A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

ASTM A824, Metallic Coated Steel Marcelled Tension Wire for Use With Chain Link Fence.

Chain-Link Fence Manufacturers Institute (CLFMI).

AASHTO M181 – Standard Specification for Chain-Link Fence.

Section 6.21 of the 1990 MDOT Standard Specifications for Construction.

1.3 QUALITY ASSURANCE. Supply material in accordance with the Chain Link Fence Manufacturer's Institute – Product Manual. The Engineer may inspect all fencing materials at the place of manufacture.

1.3.01 Contractors Qualification. Company specializing in installation of chain link fencing and gate with minimum 3 years documented experience.

1.3.02 Tolerances. Maximum Variation from Plumb shall be 1/4 inch (0.64 cm). Maximum Offset From True Position shall be 1 inch (2.5 cm). Components shall not infringe adjacent property lines.

If foundation holes are excavated in unstable soil, notify Engineer for determination of suitable construction precautions.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. All shop drawings shall conform to the provisions of Project Submittals. Shop drawings shall include cross sectional dimensions of posts, braces, rails, fittings, accessories and gate frames; design of gates; and details of all gate hardware. Layout drawings to show the spacing of posts and locations of all gates; abrupt changes in grade; and all corner, gate, anchor, end, and pull posts.

Submit data on fabric, posts, accessories, fittings and hardware along with manufacturer installation instructions and requirements.

1.4.02 Samples. Submit samples of all fencing materials to be used, in accordance with the requirements of Project Submittals. Mark or tag each sample.

1.4.03 Test Reports. Submit certified reports indicating results of tests for zinc-coating.

Submit 2 statements, one with Contractor's letterhead, and the other with subcontractor's letterhead, stating the submitted samples comply with the requirements of the Contract Documents.

Submit samples at least 30 days before erection of the fence.

1.4.04 Record Documents. Accurately record actual locations of property perimeter posts relative to property lines and easements on “as-builts” drawings.

1.5 DELIVERY, STORAGE, AND HANDLING. Fence fabric and accessories shall be delivered to the construction site in packed cartons or firmly tied rolls. Each package shall be identified and shall bear the manufacturer’s name. Store fence fabric and accessories in a secure and dry place.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Fence Height shall be 8 feet (2.4 m) or as indicated on Drawings. Line Post Spacing shall be at intervals not exceeding 10 feet (3.1 m).

2.2 MATERIALS. All chain-link fencing shall be galvanized steel. Steel pipe dimensions and weights shall conform to ASTM A53, Schedule 40. Dimensions specified are the nominal pipe sizes. Dimensions and weights specified herein are subject to a tolerance of plus or minus 5 percent.

Ferrous metal fittings, posts, fence, gate framework, and all accessories shall be galvanized with a heavy coating of pure zinc spelter using the hot-dip process. Thinner zinc-coatings and electro-galvanizing are not acceptable. Zinc paint or cold galvanizing compounds shall not be used as a substitute for the specified hot-dipped galvanized finish. The zinc-coating shall be a minimum of 2.0 oz./ sq. ft. (61mg/square cm), except where specified otherwise.

Fabrication and welding shall be done before hot-dip galvanizing. All welding shall conform to American Welding Society standards.

Provide posts with tops of same material, so designed as to fit securely over post and carry top rail or cable; base of top fitting to carry apron around outside of post.

2.2.01 Fence Fabric. Galvanized steel chain-link fabric shall conform to ASTM A392, with Class 2 zinc coating (2.0 oz./sq. ft. (61 mg/square cm) of uncoated wire surface); Fabric shall be woven in 2 inch (5.1 cm) mesh from 9 gage (3.84 mm) wire in an 8 foot (2.4 m) width with knuckled selvage on top and twisted selvage on bottom.

2.2.02 Barbed Wire And Extension Arms. Galvanized steel barbed wire consisting of three strands of twisted 12 gage (2.7 mm) wires with 4 point barbs spaced 3 inches (7.6 cm) apart and conforming to ASTM A121, with Class 2 zinc-coating.

Extension arms shall project outward, from the top of the posts, at a 45 degree angle and shall be capable of withstanding a 200 lb. (90.9 kg) downward pull on the outermost end of the arm, without failure. The upper strand of the barbed wire shall be approximately 12 inches (30.5 cm) out from the fence and 12 inches (30.5 cm) above the top of the fabric. Extension arms shall evenly space the barbed wire and shall be integral with post top weather caps with holes for passage of top rail at intermediate posts.

2.2.03 Tension Wire. Tension wire shall conform to ASTM A824, 7 gage (4.6 mm) coil spring steel wire with galvanized finish having a minimum of 0.80 oz./sq. ft. of uncoated wire surface. of zinc-coating

2.2.04 Tie Wires. Shall be minimum 9 gauge (3.84 mm) aluminum or 11 gauge (3.1 mm) galvanized steel.

2.2.05 Line Posts. Line posts shall be “C” section roll-form from steel conforming to ASTM-A570 grade 50, 1.875 x 1.625” (4.8 cm x 4.1 cm) with minimum bending strength of 274 pounds (124.6 kg) under a 6 foot cantilever load continuous coated 4 ounces (113.6 gm^3) of zinc coated per ASTM-F043 Type A, or 2.375 inches (6.0 cm)

O.D. Standard weight Schedule 40 galvanized pipe with minimum bending strength of 2.34 pounds (1.1 kg) under a 6 foot (1.8 m) cantilever load coated with 1.8 ounces of hot-dipped zinc in accordance with ASTM-F1083.

2.2.06 End, Corner And Pull Posts. End, corner and pull posts shall be 2-7/8 inch (7.3 cm) O.D. steel pipe weighing not less than 5.79 pounds/foot (8.6 kg/m)., 2-1/2 inch (6.4 cm) square steel tube weighing not less than 5.14 pounds/foot (7.7 kg/m) or 3-1/2 by 3-1/2 inch (8.9 x 8.9 cm) roll-formed, steel corner section weighing not less than 5.14 pounds/foot (7.7 kg/m). Terminal posts shall have a minimum bending strength of 443 lbs. (201.4 kg) under a 6 foot (1.8 m) cantilever load.

2.2.07 Top, Bottom, and Brace Rail. Top, bottom, and brace rails shall be roll-formed section of 1.625 inches x 1.25 inches (4.1 cm x 3.2 cm) channel shaped rail with minimum vertical bending strength of 263 pounds on 10 foot (3.1 m) span continuous coated 4 ounces (113.6 gm) of zinc coated per ASTM-F1043 Type A, or 1.66 inch (4.2 cm) O.D., Standard weight Schedule 40 galvanized pipe with minimum vertical bending strength of 235 pounds (106.8 kg) on 10 foot (3.1 m) span coated with 1.8 ounces (51.1 gms) of hot-dipped zinc in accordance with ASTM-F1083. Top, bottom, and rail couplings 6 inches (15.2 cm) minimum in length shall be spaced at maximum 21 feet (6.4 m) centers. Fabric tie wire shall be spaced at 24 feet (7.3 m) maximum centers.

2.2.08 Gates. Gate types, opening widths and directions of operation shall be shown on the Drawings. Gates shall be designed for operation by one person. Gate Fabric shall be the same chain-link fabric as used for the fence. Barbed wire shall include vertical support arms and 3 strand barbed wire as used for the fence.

2.2.09 Swing Gate. Swing gates shall be factory assembled and shall swing 180 degrees.

Gate posts, for gate leaves up to and including 6 feet (1.8 cm) wide, shall be 2-7/8 inch (7.3 cm) O.D. steel pipe weighing not less than 5.79 pounds/foot (8.6 kg/m), or 2-1/2 inch (4 m) square steel tube weighing not less than 5.14 pounds/foot (7.7 kg/m). or 3-1/2 by 3-1/2 inch (8.9 x 8.9 cm) roll-formed, steel corner section weighing not less than 5.14 pounds/foot (7.7 kg/m).

Gate posts, for gate leaves over 6 feet (1.8 m) wide and up to and including 13 feet (4 m) wide, shall be 4 inch (10.2 cm) O.D. steel pipe weighing not less than 9.10 pounds/foot (13.6 kg/m).

Gate leaf framework shall utilize 1-7/8 inch (4.8 cm) O.D. steel pipe weighing 2.72 pounds/foot (4.1 kg/m), minimum.

Gate hinges shall be heavy pattern of adequate strength for gate size, with large bearing surfaces for clamping or bolting in position.

2.2.09 Sliding Gates. Sliding gates shall be factory assembled. Each section of sliding gates shall have equal widths. Gate posts shall be 4 inch (10.2 cm) O.D. galvanized steel pipe weighting 9.10 pounds/foot (13.6 kg/m).

Gate Frames shall be fabricated of galvanized steel pipe and top and bottom members shall be 2 3/8 inch (6.0 cm) O.D. weighting 3.65 pounds/foot (5.4 kg/m). Vertical members shall be 1.9 inch (4.8 cm) O.D. weighting 2.7 pounds/foot (4.1 kg/m). Diagonal members shall be 1.66 inch (4.2 cm) O.D. weighting 2.3 pounds/foot (3.4 kg/m). Joints shall be made either by welding or by heavy fittings.

Rollers for overhead and cantilever sliding gates shall be equipped with bearings. Non-sealed bearings shall be provided with a grease fitting for periodic maintenance. Rollers shall be secured to post or frame without welding.

2.2.10 Cantilever Gates. Each section of double cantilevered gates shall have a 20 foot (6.1 m) width.

Gate posts shall be 4 inch (10.2 cm) O.D. galvanized steel pipe weighing 9.10 pounds/foot (13.6 kg/m).

Gate Frames shall be fabricated of galvanized steel pipe and top and bottom members shall be 2-3/8 inch (6.0 cm) O.D. weighing 3.65 pounds/foot (5.4 kg/m). Vertical members shall be 1.90 inch (4.8 cm) O.D. weighing 2.72 pounds/foot (4.1 kg/m). Diagonal members shall be 1.66 inch (4.2 cm) O.D. weighing 2.27 pounds/foot (3.4 kg/m). Joints shall be made either by welding or by heavy fittings.

Rollers shall be 4 each 4 inch x 2 ½ inch (10.2 x 6.4 cm) cantilever rollers at 18 lbs. (8.2 kg) each.

2.2.11 Gate Hardware. Furnish appropriate hardware for gates including gate stop and drop rod, mechanical keepers, and hardware for padlock as required.

2.2.12 Railings. Railings shall be 1-5/8 inch (4.1 cm) O.D. steel pipe with a minimum weight of 2.27 pounds/foot (3.4 kg/m) or 1-1/4 inch (3.2 cm), 14 gage (19 mm) roll-form section, for top railing and railings for top middle and bottom braces between terminal posts and adjacent line posts.

2.2.13 Truss Braces. Shall be 3/8 inch (1.0 m) diameter steel rod, diagonal truss braces between terminal and adjacent line posts and for gate framework.

2.2.14 Fittings And Post Tops. Heavy-duty malleable iron or pressed steel fittings or suitable to produce strong construction.

2.2.15 Stretcher Bars. Flat steel bars, conforming to ASTM A626, with minimum cross section dimensions of 1/4 inch by 3/4 inch (6.4 mm x 19.1 mm), full height of fabric, secured with bar bands of minimum 11 gage (3.9 mm) sheet steel, spaced approximately 15 inches (38.1 cm) on center and bolted with 3/8 inch (95.3 m) diameter bolts, for attaching fabric to terminal posts.

2.2.16 Latch. Gates shall be provided with suitable latch, accessible from both sides and with provision for padlocking.

2.2.17 Gate Padlocks. Manufactured by Eaton Corp. Lock & Hardware Div., Yale Marketing Dept., Charlotte, NC; P&F Corbin, Div. of Emhart Corp., Berlin, CT; Best Universal Lock Co., Inc., Indianapolis, IN; or acceptable equivalent and furnished with two keys each. Padlock keying shall be coordinated with Engineer.

Padlocks shall have solid brass cases, hardened steel shackles, removable core cylinders, and galvanized steel chains attached to shackle by a clevis.

2.2.18 Concrete. Concrete, for post foundation bases and maintenance strips, shall conform to the requirements specified in Master Specification Section 03300, Cast In Place Concrete. Where indicated on the Drawings, provide an 18" (45.7 cm) wide concrete maintenance strip centered under the fence line.

2.2.19 Privacy Slats. Where indicated on the drawings, provide lock-top, non-winged PVC slats as manufactured by Hoover Fence Co., Newton Falls, and Ohio. The slats shall be installed vertically between the chain-link fence fabric and shall be held in place with a horizontal locking strip. The color of the slats shall be as determined by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Any change in direction, of the fence line, of 30 degrees or more shall be considered a corner. Pull posts shall be used at any abrupt change in grade.

Post foundations shall be concrete cylinders with a minimum diameter of 12 inches (30.5 cm), crowned at grade to shed water, with 36 inches (91.4 cm) minimum depth in ground.

Place posts at each corner, having change of direction, abrupt change in grade, gate, and terminal, in addition to line and pull posts. Set post foundations in full depth of foundation except for 4 inches (10.2 cm) of concrete foundations.

Post spacing shall be uniform with a maximum spacing of 10 feet (3 m) in fences erected along straight lines. All posts shall be placed plumb and centered in concrete foundations.

Excavate post hole footings not smaller than 12 inches (30.5 cm) in diameter and 36 inches (91.4 cm) deep. Crown top of concrete to shed water, and allow to cure not less than 72 hours before proceeding with further work on posts. Embed galvanized steel eye bolts in top of footings, adjacent to posts, to receive bottom tension wire.

Brace end, corner, pull, and gate posts to nearest line post with diagonal or horizontal brace rails used as compression members, and with truss rods with turn-buckles used as tension members. Brace line posts horizontally and truss in both directions as required at approved intervals. The maximum area of unbraced fence shall not exceed 1,500 square feet (54.9 square meters).

Stretch fabric taut and tie to posts, rails, and tension wires with bottom edge following finished grade not more than 2 inches (5.1 cm) above grade. Install fabric on security side of fence and anchor to framework so that fabric remains in tension after pulling force is released. Pull fabric tight so maximum fabric deflection is 2 inches (5.0 cm) when a 30 lb. (14 kg) pull is exerted perpendicular to the center of a panel. Attach fabric to line posts with ties spaced at not more than 24 inch (61.0 cm) intervals. Attach fabric to tension wire with hog ring ties on 21 inch (53.3 cm) centers.

Install three strands of barbed wire on each extension arm of line fence and at the top of each gate. Pull wires taut and fasten at each support.

Install gates plumb, level, and secure for full width of opening and hardware adjusted for smooth operation.

3.1.02 Touch-Up And Repair Work. Remove and replace fencing, which is improperly located or is not true to line, grade and plumb within tolerances as indicated.

End of Section

SECTION 02900

LANDSCAPING

PART 1 - GENERAL

1.1 SCOPE. This section covers placing and grading topsoil, turf establishment, and the installation of trees, shrubs, and ground covers. The Contractor shall provide all materials, labor, and equipment to complete all landscape work in accordance with the drawings and specifications.

1.2 GENERAL. All landscaping and seeded or sodded areas (turf establishment) work shall be performed by a landscape contractor or nursery having demonstrated experience in the installation of plant material on projects of similar size and who employs only experienced personnel who are familiar with the required work and who shall provide adequate supervision by a qualified foreman at all times when the work is in progress.

1.2.02 Finish Grades and Soil Conditions. Shall be subject to approval before commencing work under this section.

1.2.03 Horticultural Standards. All work and material covered by this section shall be in strict accordance with standards of the American Association of Nurserymen as set forth in the latest edition of "American Standard for Nursery Stock".

1.2.04 Certificates of Inspection. All shipments of plant material shall be inspected at the nursery or at the growing site by the authorized Federal and State Agencies. All necessary inspection certificates shall accompany the invoice for each shipment.

Any plant material which indicates signs of insects, their eggs or larvae, and diseases shall be rejected and immediately removed from the project and shall be replaced with proper materials within one working day, weather permitting. Removal and replacement shall be at the expense of the Contractor.

1.3 SUBMITTALS.

1.3.01 Sample. Samples of topsoil, Humus, Peat Moss, Mulch, and Filler Fabric shall be submitted for analysis and testing; they shall be submitted in approved containers, appropriately labeled as to kind of material and its sources.

1.3.02 Test Reports and Certificates. Shall be submitted as specified in Master Specification Section 01080, Project Submittals.

1.3.03 Certification. Certificates of inspection for plant materials and material certificates for landscape materials shall be submitted in Project Submittals section.

1.3.04 Planting Schedule. The proposed planting schedule shall be submitted indicating dates for each type of landscape work during normal seasons for such work in the area of the site. Once accepted, dates shall be revised only if accepted in writing and after documentation of reasons for delays.

1.3.05 Maintenance Instructions. Typewritten instructions shall be submitted which recommend procedures to be established by the Engineer for maintenance of landscape work for one full year. Maintenance procedures shall be performed by the Contractor for recommended procedures.

1.3.06 Landscape Foreman. The Contractor shall submit to the Engineer in writing the name of the landscape foreman to be in attendance at the project site during progress of the work. Should a change in foremanship be necessary during any period in the progress of the work, the Engineer shall be notified promptly and the name of the new foreman submitted.

1.4 SUBSTITUTIONS. If a plant is found not to be available, the Contractor shall notify the Engineer. The Engineer will select a reasonable alternate or inform the Contractor of the availability of the original plant. If a substitution is selected, it shall be of the same size, value, and quality as the original plant.

1.5 WARRANTY.

1.5.01 Guaranteed Period. All seeded and sodded areas and all trees and shrubs shall be subject to one year correction period which shall commence upon the date of Final Acceptance by the Engineer. Any turf, tree, or shrub, planted during this period, which dies or partially dies to the point that the main leader has died back or there is 25 percent or more of the crown dead, shall be replaced at the Contractor's expense. Replacements made under the Contractor's warranty shall be covered by a like warranty for a period of one year after completion of the replacement. Rejection of plants by the Engineer will be final. When notified by the Engineer that certain plants, seeded or sodded areas require replacement, the replacements shall be made within 30 days of notification, providing the 30 day period falls within the planting season.

1.5.02 Replacements. All replacements shall be of the same kind and size as originally planted and shall be made at no extra cost. The Contractor shall repair any damage, including ruts in seeded, sodded, or bed areas incurred in making replacements.

At the direction of the Engineer, replacements may be planted at the start of the next planting and digging season. In such cases, dead trees and shrubs shall be removed within a reasonable time.

1.5.03 Notification. The Engineer will conduct additional inspections, and will notify the Contractor of any plants that die or require replacement during the one-year warranty period. The Contractor shall provide and coordinate planting of replacements.

1.5.04 Final Warranty Inspection. At the conclusion of the warranty period, the Contractor and Engineer shall conduct a final warranty inspection at a time mutually agreeable. It will be the Contractor's responsibility to notify the Engineer in writing requesting the inspection. The Owner will assume full responsibility after Final Warranty Inspection Approval.

1.6 DELIVERY, STORAGE AND HANDLING.

1.6.01 Packaged Materials. Packaged materials shall be delivered in containers showing weight, analysis, and name of manufacturer. Materials shall be protected from deterioration during delivery and while they are stored at the site.

Each plant packed or shipped individually and each bundle of plants, shall bear, intact upon arrival at the job site, a substantial label on which is legibly written or printed the true name in full of the plant and its size or age.

1.6.02 Plant Material. Give the Engineer at least 48 hours notice before making any delivery of plant material or sod. Plants shall be handled with care at all times to avoid damage to the roots and branches. Trees with broken leaders will be rejected. Dumping, dropping, or dragging of plants will not be permitted. Plants shall be protected from sun and wind. Root balls shall be kept damp or wet during the interim period from delivery to planting. When transporting plants to the site, provisions shall be made to protect the material from wind damage by using an anti-desiccant and avoiding high speeds, by transporting in enclosed or partially enclosed vehicles, or by covering with burlap or other suitable material. Plants damaged by wind will be rejected. This applies to trees supplied by hydraulic tree spade, as well as balled and burlapped trees.

Trees and shrubs shall be delivered after preparation for planting has been completed and shall be promptly planted. If planting is delayed more than 6 hours after delivery to the planting area, trees and shrubs shall be set in shade, protected from weather and mechanical damage, and roots shall be kept moist by covering with mulch, burlap, or other acceptable means of retaining moisture.

Container-grown stock shall not be removed from containers until the time of planting.

1.7 PROJECT CONDITIONS

1.7.01 Time of Planting. The Contractor shall perform planting activities only during periods within the planting season when weather and soil conditions are suitable for each species to be planted and in accordance with local accepted practice. Digging and delivery of plant material shall be made in the dormant season, preferably between the following dates:

Deciduous Material	March 1 to May 15, October 1 until ground freezes
Evergreen Material	March 1 to June 1, August 1 to October 1
Ground Covers	April 15 to June 1

Seeding and sodding shall be performed between the dates of May 1 and October 10, provided adverse conditions do not exist.

1.7.02 Soil and Drainage Conditions. The Contractor shall notify the Engineer in writing of all soil or drainage conditions, which the Contractor considers detrimental to growth of plant material. The Contractor shall state conditions and submit a proposal for correcting conditions, if feasible, including change in cost, if any.

If rock, underground construction work, tree roots, or obstructions are encountered in the excavation of plant pits, alternate locations may be selected by the Engineer. Where locations cannot be changed as determined by the Engineer, the cost required to remove the obstructions to a depth of not less than 6 inches (15.2 cm) below the required pit depth shall be submitted. Work will proceed only after acceptance by the Engineer. Fragmented bedrock that can be reasonably removed shall not be considered an obstruction.

1.7.03 Sequencing. Landscape work shall progress as rapidly as portions of the site become available, working within seasonal limitations for each kind of landscape work required. Final grades shall have been established, top soil spread and bound to subgrade, fills and backfills allowed to settle, the irrigation system installed and operational, and any required mechanical compaction completed before commencing work in any area.

Trees and shrubs shall be planted after final grades are established and prior to planting of grass, or placing sod, unless otherwise acceptable to the Engineer. If planting of trees and shrubs occurs after seeding, sprigging, or sodding work, the grass areas shall be protected, and damage to these areas resulting from landscaping operations shall be promptly repaired.

1.7.04 Job Conditions. All existing trees and other plant material to remain shall be clearly designated and marked under the direction of the Engineer and shall be properly protected by means of fencing or by another approved manner. Any existing trees or plant material designated to remain that is subsequently damaged by operations under this Contract shall be replaced with plant material of the same size and kind at the Contractor's expense.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Topsoil. Topsoil for planting operations shall be fertile, friable, natural loam containing a liberal amount of humus, and shall be capable of sustaining vigorous plant growth and shall not be delivered in a frozen state. Topsoil shall be free of subsoil and shall be reasonably free of stone, lumps, clods of hard earth, plants or their roots, stalks, and other extraneous matter. Topsoil shall contain at least five percent (5%) but not more than twenty percent (20%) by weight of organic matter.

If it is necessary to bring topsoil into the site it shall be subject to inspection and approval at the sources of supply or upon delivery.

2.1.02 Fertilizer. Fertilizer shall be pelleted or granular in an analysis of equal parts of available nitrogen, phosphorus and potash such as 12-12-12. Nitrogen shall be a combination of inorganic and slow release or slowly soluble substances. Fertilizers shall be delivered mixed in standard size bags of the manufacturer showing weight, analysis, and the name of the manufacturer. If not used immediately after delivery, it shall be stored in a dry place in such a manner that its effectiveness will not be impaired.

Fertilizer for tree and shrub planting areas shall be Osmocote slow release 13-13-13, or equal.

2.1.03 Mulch. Mulch for application to seed bed areas shall include straw and wood cellulose fiber.

Mulch for planting areas shall be wood chip mulch of a long fibrous nature, 2 inches to 4 inches in length. Material shall be free of all foreign debris including clods, adhering films of dirt, weed seeds, and roots.

Straw mulch shall be baled, dry, unweathered, and shall not contain an excessive amount of seed as determined by the Contractor. Material for anchoring straw shall be as per Division 9 of the MDOT Standard Specifications for Construction.

Wood cellulose fiber mulch for hydromulching shall be equal to "Hydro Mulch" as manufactured by Conwed Corp. of St. Paul, Minnesota.

2.1.04 Manure. Manure shall be well rotted, unleached stable or cattle manure containing not more than 25 percent by volume of straw, sawdust or other bedding materials and containing no chemicals or ingredients harmful to plants.

2.1.05 Guying and Staking Material. Stakes shall be sound hardwood, free of loose knots and holes, and at least 8 feet (2.4 m) long for all deciduous trees. Stakes shall be #5 rebar at least 3 feet (91.4 cm) long for all coniferous trees. Wire for tree bracing and guying shall be 12 gage double-strand, twisted, galvanized steel wire. Hose for covering wire shall be rubber hose of the same color throughout the work.

2.1.06 Seed. Seed shall be certified seed tagged and sealed in accordance with Federal and State seed laws. Samples of all seed used shall have been tested within 9 months prior to seeding by an official seed testing laboratory. Seeding mixtures shall have a maximum weed seed content of 0.5 percent, with no noxious weed seed, and shall be composed of certified seed of the purity, germination, and proportion by weight as indicated below:

Species	Percent Mix
Norlea Perennial Ryegrass	30
Kentucky BlueGrass	30
Creeping Red Fescue	40

Seed shall be furnished in sealed, standard containers with certification label attached. Seed that is wet or moldy or that has been otherwise damaged in transit or storage will not be acceptable.

2.1.07 Sod. Sod shall be nursery grown and composed of the following mixture:

Species	Percent Mix
Perennial Ryegrass	30
Kentucky Bluegrass	30
Creeping Red Fescue	40

Sod shall be machine cut at a uniform soil thickness of 1 - 1 1/2 inches (2.5 – 3.8 cm), plus or minus 1/4 inch (0.6 cm), at the time of cutting. Measurement for thickness shall exclude top growth and thatch.

Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2 inch (1.3 cm) on width and plus or minus 5 percent on length. Broken pads and torn or uneven ends will not be acceptable.

Standard-sized sections of sod shall be strong enough to support their own weight and should retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) will adversely affect its survival.

Before stripping, sod shall be mowed uniformly to a height of 1 to 2-1/2 inches (2.5 – 6.4 cm).
Sod shall be relatively free of thatch, up to 1/2 inch (1.3 cm) allowable (uncompressed).

Sod shall be reasonably free of diseases, nematodes, and soil-borne insects.

Sod shall be free of objectionable grassy and broadleaf weeds. Sod shall be considered free of such weeds if less than 5 such plants are found per 100 square feet (9.3 square meters). Sod will not be acceptable if it contains any of the following weeds: quackgrass, Johnson grass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, wild garlic, ground ivy, perennial sorrel, bromegrass, bentgrass, and Bermuda grass.

2.1.08 Trees and Shrubs. The proportions and branching of all trees and shrubs shall be in strict accordance with the standards of the American Association of Nurserymen as published in the "American Standard for Nursery Stock", ANSI Z60.1-1981. Trees and shrubs shall have a normal habit of growth and shall be well-branched, vigorous, healthy, and free from insect infestations, insect eggs or larvae, and disease. Trees with weak, thin trunks which are not capable of self-support when planted in the open are not acceptable. Trees with bad crotches, broken or unidentifiable leader, lopsided growth, or weak open structure are not acceptable. All trees and shrubs of any one species shall have the same general form and character. All trees and shrubs shall be nursery grown and true to name. Balled and burlapped plants shall be freshly dug when dormant. Collected plants are not acceptable. Plants from cold storage, from the past season, and heeled-in plants are not acceptable. Balls shall be firm and tightly wrapped. No balled plant shall be planted if the ball is cracked, broken, or mushroomed. The size of the ball shall conform to minimum sizes in ANSI Z60.1.

2.1.09 Water. Water shall be furnished by the Contractor. The Contractor shall also provide all necessary hoses, hose connections, temporary pipe, and other equipment necessary for watering.

2.1.10 Edging. Edging shall be 1/8 inch (0.3 cm) by 6 inch (15.24 cm) by Permaloc aluminum edging, or approved equal.

2.1.11 Selective Pre-emergence Herbicide. Surflan, Devrinol, Betasan, or Dacthal herbicide shall be used.

2.1.12 Weed Barrier and Filter Fabric. DuPont Typar 3201 Filter Fabric shall be used. A full product fact sheet and sample shall be submitted to the Contractor for consideration.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 General. Prior to grading and tilling, vegetation that may interfere with operations shall be mowed, grubbed, and raked. The collected material shall be removed from the site. The surface shall be cleared of stumps, stones larger than 3 inches (7.62 cm), roots, cable, wire, and other materials that might hinder the work for subsequent maintenance.

Locations of underground utilities shall be determined prior to any excavation. Work shall be performed in a manner which will avoid possible damage. Hand excavation will be used as required. Grade stakes shall be maintained until removal is mutually agreed upon by parties concerned.

Landscaping work shall not be started until substantially all earthwork has been completed. Backfills and fills shall be allowed to settle and finish grading completed immediately before the work is started. All surface and subsurface construction debris shall have been removed completely.

3.1.02 Tree and Shrub Location Staking. The Engineer and Contractor will inspect the tree and shrub bed location staking prior to installation. The Engineer reserves the right to move, shift, or adjust any or all of the stakes to better achieve the planting design intentions as shown on the drawings. Planting shall commence only upon approval of this inspection.

3.1.03 Quantity and Quality of Trees and Shrubs. No plant shall be planted until it is inspected and approved by the Engineer. The Engineer may inspect trees and shrubs either at the place of growth or at the site of collection, for compliance with requirements for genus, species, variety, size, and quality. The Engineer retains the right to further inspect trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Rejected trees or shrubs shall be immediately removed from the project site.

3.1.04 Planting Operating. Planting operations shall proceed under a well-organized program and according to accepted nursery practices. Plants shall be planted within three days upon delivery to the site. The Contractor shall be held solely liable for damage to existing utilities and other structures.

3.1.05 Placing Topsoil. Place topsoil in areas where seeding, sodding or planting is required to a nominal depth of 3 inches (7.6 cm) plus or minus 1/2 inch (1.3 cm). Place topsoil during dry weather. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade. Remove roots, weeds, rocks, and foreign material while spreading. Manually spread topsoil close to plant, building, to prevent damage. Remove surplus subsoil and topsoil from site. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.1.06 Grading. Established grades, as indicated on the drawings, shall be maintained in a true and even condition. Eroded areas and areas having inadequate drainage, as indicated by the ponding of water, shall be filled. Ruts, deep tracks, dead furrows, and ridges shall be eliminated.

3.1.07 Tilling. The area to be seeded or sodded shall be thoroughly tilled to a depth of at least 3 inches by discing, harrowing, or other accepted methods until the soil is well pulverized and smoothed by harrowing, floating, or dragging. After completion of the tilling operation, the surface shall be cleared of all stones, stumps, or other objects larger than 1-1/2 inches (3.8 cm) in thickness or diameter, and of roots, wire, grade stakes, and other objects that might be a hindrance to maintenance operations. Paved areas over which hauling operations are conducted shall be kept clean and dirt that may be brought upon the surface shall be removed promptly.

Any objectionable undulations or irregularities in the surface resulting from tillage or other operations shall be removed before seeding begins. Bed preparation shall be performed only during periods when satisfactory results are likely to be obtained. When results are not satisfactory because of drought, excessive moisture or other causes, the work shall be stopped until such conditions have been corrected to the satisfaction of the Engineer.

All operations shall be done in a direction parallel to proposed contour lines, and not uphill nor downhill.

3.1.08 Fertilizing. Fertilizer shall be applied within 24 hours prior to the tilling operation. The material shall be distributed uniformly over the entire area. Fertilizer shall be applied at a rate to give one and one-half pounds (0.68 kg) of each pure chemical per 1000 square feet (92.9 square meters) such as 12 pounds (5.5 kg) of 12-12-12, or 15 pounds (6.8 kg) of 10-10-10 per 1000 square feet (92.9 square meters). Alternatively, follow recommendations for fertilizer and lime application rates based upon topsoil testing.

3.1.09 Seeding. Seeding equipment calibration tests shall be made to determine the equipment setting required to apply the seed at the specified rates. In unplanted skips and areas noted after germination and growth of the grass, the unplanted areas shall be seeded at no additional cost. The seed box shall be kept at least half full during seeding operations to ensure even distribution of seed over all the areas seeded.

Leguminous seeds shall be inoculated with a standard pure culture of nitrogen fixing bacteria. The culture shall be mixed with sufficient water to distribute it thoroughly. The seed shall be wetted thoroughly with the solution and allowed to dry sufficiently to be in condition for sowing. Inoculated seed shall be sown within 30 hours after the treatment.

All areas shall be seeded with five pounds of seed per 1000 square feet (92.9 square meters).

Seeding and fertilizing shall not be done during periods of severe drought, high winds, excessive moisture, muddy or frozen ground, as determined by the Engineer, because satisfactory results are not likely to be obtained.

Do not seed areas in excess of that which can be mulched on same day.

Provide recommendation for fertilizer and lime application rates for specified seed mix as result of topsoil testing.

Refer to additional requirements of the current edition of MDOT Standard Specifications for Construction.

3.1.10 Covering and Firming. Unless a cultipacker type seeder is used, the seed shall be covered with a shallow-set spike tooth harrow or a chain, plank, or brush drag. The depth of cover shall not exceed 1/4 inch. In small areas, covering may need to be performed by light hand raking. After covering, the areas shall be firmed by rolling or with the use of a cultipacker.

3.1.11 Mulching. Straw mulch shall be spread uniformly in a continuous blanket at 1-1/2 inch depth loose measurement. Mulch shall be spread by hand or by a blower type mulch spreader. All wire from baled mulch shall be collected as it is removed from the bale.

Wood cellulose fiber mulch as specified shall be applied at a rate of one ton (900 kg) per acre (0.4 ha) in areas designated by the Engineer. A 4 foot by eight foot (1.2 x 2.4 m) plywood sheet shall be used along all walks and structures to prevent overspray.

Immediately following spreading, the straw mulch shall be anchored in the soil to a depth of 2 to 3 inches (5.08 to 7.6 cm) by a coulter disc mulch anchor machine designed to force the mulch into the soil surface. The machine shall be weighted and operated in such manner to secure the mulch firmly in the ground to form a soil-binding mulch and prevent loss or bunching of the hay by wind. The coulter shall be at least 10 inches (25.4 cm) in diameter. Mulch shall be secured within 24 hours after seeding. Two or more passes may be required to anchor the mulch to the satisfaction of the Engineer.

3.1.12 Protection. After completion of construction operations, seeded areas shall be protected where necessary against traffic by erecting barricades or placing warning signs in appropriate areas. Such protective devices shall be maintained until final acceptance of the project.

3.1.13 Sodding. Sodding shall be to the complete satisfaction of the Engineer. Areas which do not exhibit an acceptable stand of grass following seeding shall be sodded at the Contractor's expense. All sod used shall be best quality, and, when placed, shall be live fresh growing grass with soil adhering to the roots.

All sod shall be procured from areas where soil is fertile and contains a high percentage of loamy topsoil and from areas that have been grazed or mowed sufficiently to form a dense turf.

Sod shall be transplanted within 24 hours from the time it is harvested, unless stacked at its destination in a suitable manner. All sod in stacks shall be kept moist and protected from exposure to the sun and from freezing. In no event shall more than one week elapse between cutting and planting.

During periods of higher than optimal temperature and after all unevenness in the soil surface has been corrected, the soil shall be lightly moistened immediately prior to laying the sod.

Before placing sod, all shaping and dressing of the areas shall have been completed. After shaping and dressing, commercial fertilizer of a type acceptable to the Engineer shall be applied uniformly in the manner and amounts recommended by the manufacturer, and harrowed lightly. Sodding shall follow immediately.

The first row of sod shall be laid in a straight line, with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to avoid stretching or overlapping the sod and to ensure that all joints are butted tight in order to prevent voids which would cause air drying of the roots.

The Contractor shall water sod immediately after transplanting to prevent excessive drying. As sodding is completed in any one section, the entire area shall be rolled. It shall then be watered to a sufficient depth to thoroughly wet the underside of the new sod pad and the soil immediately below the sod.

Sod shall be staked on slopes of 3:1 or steeper; however, the Contractor shall be solely responsible for replacing sod displaced by erosion or other causes.

All sodding shall be done during the period from May 1 to October 1, unless written permission is given by the Engineer to extend the planting season.

3.1.14 Planting Trees and Shrubs. Preparing Shrub Beds: Osmocote shall be spread at a rate of 20 pounds (9 kg) per 100 square feet (9.3 square meters). Soil shall be cultivated to a depth of not less than 8 inches (20.3 cm) to incorporate the fertilizer and manure and break up the compacted soil. Grass, weeds, sods, stones larger than 2-1/2 inches (6.4 cm) in any dimension, clay lumps, and other extraneous material shall be removed to the depth of tillage. Beds shall be mulched with wood chips as specified.

Where existing tree roots are encountered, reduce the depth of tillage and soil amendments proportionately as required to avoid root injury.

3.1.15 Preparing Shrub Beds. Trees and shrubs shall be set in the center of pits, plumb and straight and planted in accordance with the details on the drawings. Backfill soil shall be worked around the root ball and water-settled to eliminate air pockets. Any wire or nylon twine tied or wrapped around the base of the plant shall be removed. All plastic wraps shall be removed. For plants supplied in wire baskets, at least the top 10 inches (25.4 cm) of wire shall be cut away and removed from the pit. The surface for a radius of 2 feet (61.0 cm) and depth of 2 to 4 inches (5.1 0 10.1 cm) around the tree shall be loosened and slightly saucered to retain moisture and act as a mulch.

3.1.16 Fertilizing. Osmocote shall be surface broadcasted over the entire pit area at the rate of 1.8 pounds (0.8 kg) per square yard (0.8 square meters) and shall be mixed into the top 6 inches (15.2 cm) of soil. A guaranteed analysis shall be shown on each bag and the content, testable to ten percent (10) nitrogen, six percent (6) available phosphoric acid and four percent (4) total potash. All trees shall have an application of fertilizer after planting at approximately 1 pound (0.5 kg) per inch of caliper. The fertilizer shall be raked into the top surface above the root system of the plant.

3.1.17 Watering. As planting is completed, each tree and shrub shall be watered thoroughly to settle the plants and eliminate air pockets. All plants shall be watered after planting regardless of soil moisture conditions.

3.1.18 Wrapping and Staking. Shade trees shall be wrapped in a spiral manner with the overlap to one-half (1/2) the width of wrapping. The wrapping shall be securely fastened. Wrapping strips shall be 6 to 10 inches (15.2 – 25.4 cm) in width, free from holes and tears. Either burlap or waterproof crepe paper may be used.

All trees between 1-1/2 inch and 4 inches (5.8 and 10.2 cm) in caliper shall be carefully and adequately staked. Supporting stakes shall be of sound wood uniform in size, and not less than two by 2 inches (5.1 x 5.1 cm) in section. Wire used shall be 12 or 14 gauge (2.7 mm or 1.9 mm) pliable galvanized wire. Hose used for covering wire shall be at least 1/2 inch (1.3 cm) fabric rubber hose. Used hose is acceptable if approved prior to installation. The trees shall be protected by passing wire through sections of rubber hose. The wire shall be so looped that it bears only one side of the tree and in no case shall the wire loop around the truck or branches. Maintain stakes to the end of the guarantee period.

Guying and staking shall be performed before backfilling and watering and as indicated on the drawings.

3.1.19 Pruning. After planting, only deadwood, suckers, and broken or badly bruised branches shall be removed. Pruning shall be performed by shortening branches back to the nearest lateral branch or live bud. The leader shall not be cut. Stubs shall not be left. The natural form and balance of the tree or shrub shall be retained. Trees with heavy tops shall have about one-third to one-half (1/3 to 1/2) of the preceding season's growth removed. Care shall be taken in pruning to preserve the natural character of the plant. Dead, broken and badly bruised branches shall be removed with a clean cut. All cut surfaces over 1 inch (2.5 cm) in diameter shall be tree painted.

3.1.20 Weed Barrier. Weed barrier shall be installed under all mulch in locations indicated on the drawings. The weed barrier shall be placed under mulch on a clean weed- and grass-free and uniformly graded surface and cut to fit neatly against adjacent walls, walks, and edgings. Barrier overlaps shall be at least 4 inches (10.2 cm). The mulch shall be placed at a uniform depth of 2 inches (5.1 cm) over the weed barrier. After installation, no weed barrier shall protrude above the mulch or along edges.

3.1.21 Mulching. Shredded bark shall be installed to a uniform depth of not less than 2 inches (5.1 cm) to the outside diameter of the pit for trees and shrubs, and in the limits of shrub beds.

3.1.22 Edging Material. Edging shall be installed around each planting area to separate seeded and sodded areas from mulched areas. Edging shall be installed in accordance with the manufacturer's recommendations.

3.1.23 Pre-Emergence Herbicide. A pre-emergence herbicide shall be applied at the rate recommended by the manufacturer to all shrub beds and within the limits of mulch at the base of the trees.

3.2 CLEAN UP. After completion of the planting operations, the entire site shall be cleared of excess soil and waste material resulting from the Contractor's work including, but not limited to, stones, stumps, roots, brush, wire, grade stakes, and all objects that might be a hindrance to maintenance operations or affect the visual appearance of the site. Soil clods and debris left on the surface shall be removed.

3.3 MAINTENANCE. The Contractor shall maintain all material beginning immediately after the work is started and continuing until final acceptance. The Owner will assume all maintenance work upon final acceptance, including the removal of stakes and guy wires at the proper time.

3.3.01 Watering. Maintenance shall include a thorough initial watering with programmed or hand watering of trees, shrubs, seeded and sodded areas and ground cover beds thereafter when soil moisture is below optimum level for establishment and growth. Watering in seeded areas shall be by fine mist.

3.3.02 Resetting Plants, Stakes and Guys. Settled plants shall be reset to proper grade and position, dead material removed, and guys tightened or repaired within a reasonable time.

3.3.03 Pruning. Pruning will include only work that is necessary to maintain the plants in their normal growth pattern.

3.3.04 Replacing Dead and Partially Dead Plants. Plant replacement shall be made as specified.

The Contractor shall assume responsibility of maintaining work until final acceptance. Minimum of one (1) maintenance trip every two (2) weeks shall be made to the site during the growing season. Notify the Engineer at least 2 work days prior to each maintenance trip.

3.3.05 Maintenance of Grades and Repair of Erosion Damage. Original grades of the grass areas shall be maintained after commencement of planting operations and during the maintenance period. Any damage to the finished surface from construction operations shall be promptly repaired. In the event erosion occurs from either watering operations or rainfall, such damage shall be promptly repaired. Ruts, ridges, tracks, washouts or gullies and other surface irregularities shall be corrected and areas replanted where required.

3.3.06 Maintenance of Lawn Areas. Shall consist of watering, mowing, fertilizing, weed control, re-sodding or re-seeding bare areas if necessary, repair of erosion damage, maintenance of mulch, trimming, edging and any other operation necessary to produce a first quality lawn. The lawn shall be mowed as necessary, keeping the lawn height to a maximum of 3-1/2 inches (8.9 cm) until acceptance. Do not cut more than 1/3 of grass blade at any one mowing. The first mowing shall take place when seedlings are 40 percent higher than desired height. Neatly trim edges and hand clip where necessary and immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps. The Contractor shall provide all maintenance of the lawn areas as described until it has been thoroughly established.

3.3.07 Maintenance of Plantings. Maintenance of plantings shall consist of watering, cultivating, weeding, pruning, fertilizing, keeping plants erect, raising plants which settle below grade, maintaining tree stakes and applying such sprays as are necessary to keep the plantings free of insects and disease.

3.3.08 Maintenance of Mulched Areas. Mulch in seeded areas shall be maintained until covered with growing grass seedlings. Mulch material that has been removed from the site by wind or other causes shall be replaced and secured. Repair work that is required because of faulty operations or negligence on the part of the Contractor shall be performed at no additional cost.

3.3.09 Weeding and/or Weed Killer Application. Shall be scheduled as necessary to keep the seeded and sodded areas and planting area as free of weeds as possible. All shrub and mulched areas around trees shall be weed free at final acceptance. Remedy damage resulting from improper use of herbicides.

3.3.10 Plant Material. Contractor agrees to guarantee all plant material for a period of two years. The Guarantee period shall start at the time of provisional acceptance

of the landscaping and terminate at final warranty inspection acceptance of the landscaping. The guarantee includes furnishing new plants as well as labor and materials for installation of replacements. Plants found to be dead or dying during the maintenance trips will be reported in writing to the Engineer. Replacement planting shall be completed no later than the next planting season with plant material conforming to the original specifications. All areas damaged by replacement operations shall be fully restored by the Contractor. First replacement plants shall be guaranteed one growing season following planting. If the first replacement plant dies, the Contractor shall be responsible for not more than one additional replacement plant per location which will carry no guarantee. Plants planted in the fall or spring will be inspected in September. The Contractor shall not assume responsibility for damage or loss of plant material resulting from natural
causes such as flood, lightning storms, freezing rains, or winds over 60 miles per hour (96.5 km/hr), nor will he be hold responsible for damages resulting from acts of negligence on the part of the Owner or others occupying the site; fires or vandalism during the guarantee period. Any tree replacement planting shall have the same guarantee as that of the original tree planting.

3.4 FINAL ACCEPTANCE. When the work has been completed, the Contractor shall notify the Engineer in writing requesting a final acceptance. At a time mutually agreeable, the Contractor and Engineer will inspect the work and report findings as to acceptability and completeness. Any work remaining to be done shall be subject to another review. The Contractor will be notified in writing by the Engineer of the provisional acceptance of completed portions of the work.

This final acceptance shall serve as the start of the guarantee period.

End of Section

SECTION 02906

PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Piping.
2. Automatic control valves.
3. Automatic drain valves.
4. Transition fittings.
5. Miscellaneous piping specialties.
6. Sprinklers.
7. Quick couplers.
8. Controllers.
9. Boxes for automatic control valves.

1.3 DEFINITIONS

1.3.01 Circuit Piping: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.

1.3.02 Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.

1.3.03 Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

1.3.04 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 PERFORMANCE REQUIREMENTS

1.4.01 Irrigation zone control shall be automatic operation with controller and automatic control valves.

1.4.02 Location of Sprinklers and Specialties: Design location is approximate. Make minor adjustments necessary to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage of areas indicated.

1.4.03 Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:

1. Irrigation Main Piping: 200 psig (1380 kPa).
2. Circuit Piping: 150 psig (1035 kPa).

1.5 SUBMITTALS

1.5.01 Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.5.02 Wiring Diagrams: For power, signal, and control wiring.

1.5.03 Delegated-Design Submittal: 100 percent coverage irrigation system, including locations of heads pipes, zones, valves, types of heads and available pressure for system.

1.5.04 Coordination Drawings: Irrigation systems, drawn to scale, on which components are shown and coordinated with each other, using input from Installers of the items involved. Also include adjustments necessary to avoid plantings and obstructions such as signs and light standards.

1.5.05 Qualification Data: For qualified Installer.

1.5.06 Zoning Chart: Show each irrigation zone and its control valve.

1.5.07 Controller Timing Schedule: Indicate timing settings for each automatic controller zone.

1.5.08 Field quality-control reports.

1.5.09 Operation and Maintenance Data: For sprinklers controllers and automatic control valves to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

1.6.01 Installer Qualifications: An employer of workers that include a certified irrigation designer qualified by The Irrigation Association.

1.6.01 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

1.7.01 Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

1.70.2 Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.8 PROJECT CONDITIONS

1.8.01 Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner’s representative no fewer than two days in advance of proposed interruption of water service.
2. Do not proceed with interruption of water service without Owner's written permission.

1.9 EXTRA MATERIALS

1.9.01 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Impact Sprinklers: Equal to 95 percent of amount installed for each type and size indicated, but no fewer than 80 units.
2. Spray Sprinklers: Equal to 5 percent of amount installed for each type and size indicated, but no fewer than 4 units.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

2.1.01 Comply with requirements in the piping schedule in this section for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.1.02 PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedules 40 and 80.

1. PVC Socket Fittings: ASTM D 2466, Schedule 40.
2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.

2.1.03 PVC Pipe, Pressure Rated: ASTM D 2241, PVC 1120 compound, SDR 21 and SDR 26.

1. PVC Socket Fittings: ASTM D 2467, Schedule 80.
2. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.

2.2 PIPING JOINING MATERIALS

2.2.01 Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick unless otherwise indicated; full-face or ring type unless otherwise indicated.

2.2.02 Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.2.03 Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.2.04 Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.3 AUTOMATIC CONTROL VALVES

2.3.01 Plastic, Automatic Control Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Buckner; a division of Storm Manufacturing Group Inc.
   b. Greenlawn Sprinkler Company.
   c. Hit Products Corporation.
   d. Hunter Industries Incorporated.
   e. Rain Bird Corporation.

3. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

2.4 AUTOMATIC DRAIN VALVES

2.4.01 Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig (17 to 20 kPa).

2.5 TRANSITION FITTINGS

2.5.01 General Requirements: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

2.5.02 Transition Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cascade Waterworks Manufacturing.
    b. Dresser, Inc.; DMD Division.
    c. Ford Meter Box Company, Inc. (The).
    d. JCM Industries.
    e. Smith-Blair, Inc; a Sensus company.
    f. Viking Johnson.

2. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.

2.5.03 Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Harvel Plastics, Inc.
    b. Spears Manufacturing Company.

2. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-socket[or threaded] end.

2.5.04 Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Colonial Engineering, Inc.

b. NIBCO INC.
c. Spears Manufacturing Company.

2. Description: MSS SP-107, PVC four-part union. Include one brass[or stainless-steel] threaded end, one solvent-cement-joint[or threaded] plastic end, rubber O-ring, and union nut.

2.6 MISCELLANEOUS PIPING SPECIALTIES

2.6.01 Water Hammer Arresters: ASSE 1010 or PDI WH 201, with bellows or piston-type pressurized cushioning chamber and in sizes complying with PDI WH 201, Sizes A to F.

2.6.02 Pressure Gages: ASME B40.1. Include 4-1/2-inch- (115-mm-) diameter dial, dial range of two times system operating pressure, and bottom outlet.

2.7 SPRINKLERS

2.7.01 General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.

2.7.02 Plastic, Pop-up, Gear-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Buckner; a division of Storm Manufacturing Group Inc.
b. Champion Irrigation Products.
c. Hunter Industries Incorporated.
g. Rain Bird Corporation.
h. Toro Company (The); Irrigation Division.
i. Weathermatic.

3. Description:

a. Body Material: ABS.
b. Nozzle: ABS.
c. Retraction Spring: Stainless steel.
d. Internal Parts: Corrosion resistant.

4. Capacities and Characteristics:

a. Flow: 3 to 6 gpm.
b. Pop-up Height: 3 to 12 inches above ground to nozzle.
c. Arc circle as indicated.

d. Radius: 40 to 50 feet.

2.7.03 Plastic, Pop-up, Impact-Drive Rotary Sprinklers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Buckner; a division of Storm Manufacturing Group Inc.
   b. Toro Company (The); Irrigation Division.

3. Description:

   a. Case: ABS.
   b. Pop-up Height: Approximately 3 inches (75 mm).
   c. Sprinkler Construction: ABS and other corrosion-resistant metals.

4. Capacities and Characteristics:

   a. Flow: 3 to 6 gpm.
   b. Pop-up Height: 3 to 12 inches above ground to nozzle.
   c. Arc circle as indicated.
   d. Radius: 40 to 50 feet.

2.8 QUICK COUPLERS

2.8.01 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Buckner; a division of Storm Manufacturing Group Inc.
4. Hunter Industries Incorporated.
5. Nelson, L. R. Corporation.
6. Rain Bird Corporation.
7. Toro Company (The); Irrigation Division.
8. Weathermatic.

2.8.02 Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.

1. Locking-Top Option: Vandal-resistant locking feature. Include two matching key(s).

2.9 CONTROLLERS

2.9.01 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hunter Industries Incorporated.
2. Rain Bird Corporation.
3. Superior Controls Co., Inc.
4. Toro Company (The); Irrigation Division.
5. Weathermatic.

2.9.02 Description:

1. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.
2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and two matching keys; include provision for grounding.

    a. Body Material: Enameled-steel sheet metal or Molded plastic.
    b. Mounting: Surface type for wall.

3. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and two matching keys.

    a. Body Material: [Enameled-steel sheet metal or Molded plastic.
    b. Mounting: Surface type for wall.

4. Control Transformer: 24-V secondary, with primary fuse.
5. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.

    a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
    b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.
    c. Surge Protection: Metal-oxide-varistor type on each station and primary power.

6. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.

7. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.

   a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
   b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
   c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

8. Concrete Base: Reinforced precast concrete not less than 36 by 24 by 4 inches (900 by 600 by 100 mm) thick, and 6 inches (150 mm) greater in each direction than overall dimensions of controller. Include opening for wiring.

2.10 BOXES FOR AUTOMATIC CONTROL VALVES

2.10.01 Plastic Boxes:

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

   a. Armorcast Products Company.
   b. Carson Industries LLC.
   c. Nationwide Plastics, Inc.
   d. Oldcastle, Inc.

2. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.

   a. Size: As required for valves and service.
   b. Shape: Rectangular unless indicated otherwise.
   c. Sidewall Material: PE, ABS, or FRP.
   d. Cover Material: PE, ABS, or FRP.

      1) Lettering: "VALVE BOX."

2.10.02 Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch (19 mm) minimum to 3 inches (75 mm) maximum.

PART 3 - EXECUTION

3.1 EARTHWORK

3.1.01 Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.1.02 Install warning tape directly above pressure piping, below finished grades, except 6 inches (150 mm) below subgrade under pavement and slabs.

3.1.03 Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from (3 inches to12 inches below grade.) Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.

3.1.04 Provide minimum cover over top of underground piping according to the following:

1. Irrigation Main Piping: Minimum depth of 36 inches (900 mm) below finished grade, or not less than 18 inches (450 mm) below average local frost depth, whichever is deeper.
2. Circuit Piping: 12 inches (300 mm).
3. Drain Piping: 12 inches (300 mm).
4. Sleeves: 24 inches (600 mm).

3.2 PREPARATION

3.2.01 Set stakes to identify locations of proposed irrigation system. Obtain Architect's approval before excavation.

3.3 PIPING INSTALLATION

3.3.01 Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.

3.3.02 Install piping at minimum uniform slope of 0.5 percent down toward drain valves.

3.3.03 Install piping free of sags and bends.

3.3.04 Install groups of pipes parallel to each other, spaced to permit valve servicing.

3.3.05 Install fittings for changes in direction and branch connections.

3.3.06 Install unions adjacent to valves and to final connections to other components with NPS 2 (DN 50) or smaller pipe connection.

3.3.07 Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 (DN 65) or larger pipe connection.

3.3.08 Install underground thermoplastic piping according to ASTM D 2774 and ASTM F 690.

3.3.09 Install expansion loops in control-valve boxes for plastic piping.

3.3.10 Lay piping on solid subbase, uniformly sloped without humps or depressions.

3.3.11 Install ductile-iron piping according to AWWA C600.

3.3.1 Install PVC piping in dry weather when temperature is above 40 deg F (5 deg C). Allow joints to cure at least 24 hours at temperatures above 40 deg F (5 deg C) before testing.

3.3.12 Install water regulators with shutoff valve and strainer on inlet and pressure gage on outlet. Install shutoff valve on outlet. Install aboveground or in control-valve boxes.

3.3.13 Water Hammer Arresters: Install between connection to building main and circuit valves aboveground or in control-valve boxes.

3.3.14 Install piping in sleeves under parking lots, roadways, and sidewalks.

3.3.14 Install sleeves made of [Schedule 80] PVC pipe and socket fittings, and solvent-cemented joints.

3.3.15 Install transition fittings for plastic-to-metal pipe connections according to the following:

1. Underground Piping:

   a. NPS 1-1/2 (DN 40) and Smaller: Plastic-to-metal transition fittings.
   b. NPS 2 (DN 50) and Larger: AWWA transition couplings.

2. Aboveground Piping:

   a. NPS 2 (DN 50) and Smaller: Plastic-to-metal transition [fittings] [unions].
   b. NPS 2 (DN 50) and Larger: Use dielectric flange kits with one plastic flange.

3.3.16 Install dielectric fittings for dissimilar-metal pipe connections according to the following:

1. Underground Piping:

   a. NPS 2 (DN 50) and Smaller: Dielectric coupling or dielectric nipple.
   b. NPS 2-1/2 (DN 65) and Larger: Prohibited except in control-valve box.

2. Aboveground Piping:

   a. NPS 2 (DN 50) and Smaller: Dielectric union.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flange.
   c. NPS 5 (DN 125) and Larger: Dielectric flange kit.

3. Piping in Control-Valve Boxes:

   a. NPS 2 (DN 50) and Smaller: Dielectric union.
   b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flange.
   c. NPS 5 (DN 125) and Larger: Dielectric flange kit.

3.4 <u>JOINT CONSTRUCTION</u>

3.4.01 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

3.4.02 Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3.4.03 Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.4.04 Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.4.05 Copper-Tubing Brazed Joints: Construct joints according to CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.

3.4.06 Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

3.4.07 PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.5 SPRINKLER INSTALLATION

3.5.01 Install sprinklers after hydrostatic test is completed.

3.5.02 Install sprinklers at manufacturer's recommended heights.

3.5.03 Locate part-circle sprinklers to maintain a minimum distance of 4 inches (100 mm) from walls and 2 inches (50 mm) from other boundaries unless otherwise indicated.

3.6 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION

3.6.01 Equipment Mounting: Install interior controllers on wall.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.6.02 Equipment Mounting: Install exterior freestanding controllers on precast concrete bases.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.6.03 Install control cable in same trench as irrigation piping and at least 2 inches (51 mm) below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

3.7 CONNECTIONS

3.7.01 Comply with requirements for piping for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventers. Drawings indicate general arrangement of piping, fittings, and specialties.

3.7.02 Install piping adjacent to equipment, valves, and devices to allow service and maintenance.

3.7.03 Connect wiring between controllers and automatic control valves.

3.8 IDENTIFICATION

3.8.01 Identify system components. Comply with requirements for identification as required and approved by owner.

3.8.02 Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

3.8.03 Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches.

3.9 FIELD QUALITY CONTROL

3.9.01 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

3.9.02 Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.9.03 Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.9.04 Any irrigation product will be considered defective if it does not pass tests and inspections.

3.9.05 Prepare test and inspection reports.

3.10 STARTUP SERVICE

3.10.01 Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that controllers are installed and connected according to the Contract Documents.
3. Verify that electrical wiring installation complies with manufacturer's submittal.

3.11 ADJUSTING

3.11.01 Adjust settings of controllers.

3.11.02 Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

3.11.03 Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than (1/2 inch above, finish grade.)

3.12 CLEANING

3.12.01 Flush dirt and debris from piping before installing sprinklers and other devices.

3.13 DEMONSTRATION

3.13.01 Train Owner's maintenance personnel to adjust, operate, and maintain automatic control valves and controllers.

3.14 PIPING SCHEDULE

3.14.01 Install components having pressure rating equal to or greater than system operating pressure.

3.14.02 Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.

3.14.03 Underground irrigation main piping, [NPS 4 (DN 100) and smaller, shall be SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

3.14.04 Underground irrigation main piping, [NPS 5 (DN 125) and larger shall be SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.

3.14.05 Circuit piping, NPS 2 (DN 50) and smaller, shall be SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

3.14.06 Circuit piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

3.14.07 Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.

1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.

3.15 VALVE SCHEDULE

3.15.01 Underground, Shutoff-Duty Valves: Use the following:

1. NPS 2 (DN 50) and Smaller: Curb valve, curb-valve casing, and shutoff rod.
2. NPS 3 (DN 80) and Larger: Iron gate valve, resilient seated; iron gate valve casing; and operating wrench(es).

End of Section

INDEX

DIVISION 3 - CONCRETE

SECTION 03100

CONCRETE FORMWORK

PART 1 – GENERAL

1.1 SCOPE. Section includes formwork for cast-in-place concrete, with shoring, bracing and anchorage; openings for other work; complete with furnishing, preparation, installation, coating, protection, adjustment, removal and accessories.

Design, engineer and construct formwork, shoring and bracing to meet design and code requirements, so that resultant concrete conforms to the required shapes, lines and dimensions of the work.

Prompt cleanup, removal, safe and proper disposal of all waste material resulting from the work herein.

Prompt and proper removal, salvage, protection, storage and turnover to the Owner of all surplus useable material resulting from the work herein.

1.2 GENERAL.

1.2.01 Governing Standards.

ACI SP-4, “Formwork for Concrete."

ACI 301, “Specification for Structural Concrete for Buildings.”

ACI 305, “Hot Weather Concreting.”

ACI 306, “Recommended Practice for Cold Weather Concreting.”

ACI 307, “Curing Concrete.”

ACI 317, “Standard Specifications for Tolerances for Concrete Construction and Materials.

ACI 318, “Building Code Requirements for Structural Concrete and Commentary.”

ACI 347, “Recommended Practice for Concrete Formwork.”

ACI 350, “Code Requirements for Environmental Engineering Concrete Structures.”

ACI 605, "Recommended Practice for Hot Weather Concrete."

ACI 614, "Recommended Practice for Measuring, Mixing and Placing Concrete."

ASTM C94, "Ready-Mix Concrete."

1.3 QUALITY ASSURANCE. The formwork shall be designed for the loads, lateral pressure, and allowable stresses outlined in "Recommended Practice for Concrete Formwork" ACI 347 and for design considerations, wind loads, allowable stresses and other applicable requirements of the local building code. The design and construction of the formwork shall be the responsibility of the Contractor.

The formwork shall be true in every respect to produce hardened concrete to the required shape, size, grade and alignment as indicated on the Plan, and of sufficient strength, bracing and rigidity to maintain their position and shape under the loads and operations incidental to placing and curing the concrete, as well as all other forces resulting from the movement of the forms. The forms shall be mortar-tight at the time concrete is placed in them and shall be so constructed that the surfaces of the finished concrete will be reasonably free from ridges, fins, offsets or similar defects. Adequate and suitable means for removing the forms without injury to the surfaces or edges of the finished concrete shall be provided.

1.3.01 Tolerances. Formwork shall be constructed such that the hardened surfaces shall conform to the tolerance limits of ACI 347, except as modified below.

Variation from plumb in lines and surfaces of piers, walls or columns in any ten (10) feet (3.05 m) of length shall not exceed ¼ inch (6.4 mm) with a maximum for entire length of 1 inch (2.54 cm).

Variation from the level or from the grades in any ten (10) feet (3.05 m) of length shall not exceed ¼ inch (6.4 mm) with a maximum for entire length of ¾ inch (1.9 cm).

Variation of distance between walls, columns and beams in any ten (10) feet (3.05 cm) of distance shall not exceed ¼ inch (6.4 mm) with a maximum for entire distance of 1 inch (2.54 cm).

Variation of the linear lines from the established position as indicated on the Plan in any 20 feet (6.1 m) of length shall not exceed ½ inch (1.27 cm) with a maximum for entire length of 1 inch (2.54 cm).

Variation in sizes and locations of sleeves, floor openings, and wall openings shall not exceed minus ¼ inch (6.4 mm) or plus ½ inch (1.27 cm).

Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls shall not exceed minus ¼ inch (6.4 mm) or plus ½ inch (1.27 cm).

Variation of footing dimensions in Plan shall not exceed minus ½ inch (1.27 cm) or plus 2 inches (5.08 cm).

Thickness shall not exceed minus 5%.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit all formwork and shoring shop drawings and their associated calculations. Indicate the pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports. Also show means of leakage prevention for concrete exposed to view in the finished construction. Indicate sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift and height of drop during placement. Vertical, horizontal and special loads shall be in accordance with ACI 347, Section 2.2 and camber diagrams, if applicable. The shop drawings and their associated calculations shall be signed and sealed by an engineer registered in the State of Michigan.

Notes to formwork erector showing size and location of conduits and piping embedded in concrete in accordance with ACI 318, Section 6.3.

Submit data on void form materials (and installation requirements).

1.5 DELIVERY, STORAGE AND HANDLING. Deliver forms and installation instructions in manufacturer's packaging. Store off ground in a ventilated and protected manner to prevent deterioration from moisture.

Store and handle form coating to prevent contamination of coating in accordance with manufacturer's recommendations.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that permissible working stresses are not exceeded.

Beams and slabs supported by concrete columns shall be formed so that the column forms may be removed without disturbing the supports for the beams or slabs.

Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be placed at the proper locations on the forms so that the concrete surface can be finished with a screed or template to the specified elevation, slope or contour. At horizontal construction joints in walls, the forms on one side shall not extend more than 2 feet (60.96 cm) above the joint.
Provide openings in concrete formwork to accommodate work of other trades, sized and located accurately. Securely support items built into forms; provide additional bracing at openings and discontinuities in formwork.

Temporary openings shall be provided at the bottom of the column and wall forms and at other points where necessary to facilitate cleaning and inspection. Close with tight-fitting panels designed to minimize appearance of joints in finished concrete work.

2.1.01 Formwork Design Requirements – General. Produce shop drawings showing details of form type including tunnel and shaft forms, methods of form construction erection, and removal, design computations, location of form joints, form ties, and shoring. Keep a copy of drawings in field office during erection.

Provide and design formwork to support vertical and horizontal loads and lateral pressure resulting from placement and vibration of concrete in accordance with ACI-347.

Provide and design formwork to locate bracing which will maintain form stability, and to comply with the tolerances specified.

Provide and design formwork to anticipate deflection and creep due to weight and pressure of fresh concrete and construction loads. Camper shall be designed into the formwork to compensate for anticipated deflection and creep due to the weight and pressure of the fresh concrete, prestressing loads, and construction loads.

Provide and design form openings to allow placement and consolidation of concrete without segregation. Provide drop chutes or drop pipes to prevent accumulation of hardened concrete on forms and reinforcement above fresh concrete and to prevent concrete segregation.

Provide and design forms to conform to expansion and construction joint locations indicated, and to match architectural lines.

External corners shall be chamfered ¾ -inch unless otherwise noted.

Forms for all exposed surfaces shall be such as to provide an as-cast concrete surface, and equivalent to a rough form finish as specified in Section 10.2.1 of ACI 301.

2.2 ACCEPTABLE MANUFACTURERS. Provided they comply with the contract documents, these manufacturers are acceptable.

Fitzgerald Formliners, 7730 Strathmore Road, Dublin, OH 43016
(614) 798-0354

Alabama Metal Industries Corp., 3245 Fayette Avenue, Birmingham, AL 35208 (205) 787-2611

Molded Fiberglass Construction Products, 1018 W. Sycamore Street, Independence, KS 67301 (316) 331-7366

2.3 MATERIALS

2.3.01 Forms. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall conform to ACI 347 and the following additional requirements.

Prefabricated forms shall be Simplex “Industrial Steel Frame Forms”, Symons “Steel Ply” or Universal “Uni-form”.

Plywood shall be Product Standard PS-1, waterproof, resin-bonded, exterior type Douglas Fir, face adjacent to concrete Grade B or better.

Fiberboard shall be ANSI/AHA A135.4, Class 1, tempered, water-resistant, concrete form hardboard.

Lumber shall be straight of uniform width and thickness, and free from knots, offsets, holes, dents and other surface defects.

Chamfer Strips shall be Clear white pine, surface against concrete planed.

2.3.02 Forms for Smooth Form Finish Concrete. Forms for surfaces which will be exposed to view, when construction is completed, shall be constructed of prefabricated plywood panels, metal panels, fiber-reinforced plastic panels, job-built of plywood or lined with plywood or fiberboard. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimensions of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and concave or convex areas, within the tolerances specified herein. Furnish largest practicable sizes to minimize joints and to conform to joint system shown on drawings.

2.3.03 Forms for Rough Form Finish Concrete. Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the interior of manholes, basins, and reservoirs. Other types of forming materials, such as steel or unlined wood, may be used where plywood or lined forms are not required and may be used as backing for form linings. Concrete forms are required above all extended footings. Use lumber dressed on two edges and one side for tight fit.

2.3.04 Forms for Cylindrical Columns and Supports: Metal, fiberglass-reinforced plastic or paper or fiber tubes. Construct paper or fiber tubes of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation. Flat segmented forms not more than 24 inches (60.96) wide may be used for forming curved surfaces 25 feet (7.62 m) in diameter or larger.

2.3.05 Forms for Textured Finish Concrete. Use units with face design, size, arrangement and configuration to match Engineer's control sample. Provide solid backing and form supports to stabilize textured form liners.

2.3.06 Earth Forms. Hand trim bottoms and sides of earth forms to profiles required. Remove loose dirt before placing concrete.

2.4 FORM SURFACES.

2.4.01 Lumber. Use straight, uniform width and thickness, free from knots, offsets, holes, dents, warpage and other surface defects.

2.4.02 Plywood. Use product standard psi, waterproof, resin-bonded, exterior-type Douglas Fir, face adjacent to concrete Grade B or better.

2.4.03 Metal. Use smooth metal plate free of surface irregularities.

2.4.04 Chamfer Strips. Use clear white pine, surface against concrete planed, 1 inch (2.54 cm) bevel width or cant strip.

Forms shall be coated in accordance with manufacturer's recommendations before the form or reinforcement is placed in final position. Surplus coating on form surfaces, or any coating on reinforcing steel and construction joints shall be removed before placing concrete.

Commercial formulation form-coating compounds with no more than 350 mg/ltr volatile organic compounds (VOCs) that do not bond with, stain, or adversely affect concrete surfaces, or prevent good bonding with later concrete surface treatments.

Non-staining and non-toxic after 30 days: Burke "Spectrum Release Agent", L&M Chemical "Debond", Master Builders "Pro-Cote", Nox-Crete "Chembetron 103", or Symons "Thrift Kote".

2.5 FORM TIES. Form ties shall be of the removable end, permanently embedded body type, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie, and the permanently embedded portion shall be at least 1 inch (2.54 cm) back from the concrete face and leave not more than 1 inch (2.54 cm) diameter hole in concrete surface. Form ties for liquid-bearing walls shall be provided with water stop washers located on the permanently embedded portions of the ties at the approximate center of the wall. Permanently embedded portions of form ties without threaded ends shall be constructed so that the removable ends are readily broken off without damage to he concrete. Tie wire shall be mild steel or annealed iron, minimum 16 gage, Dayton "Sure Grip" or Richmond "Snap-Tys" Form Ties, or approved equal.

At locations approved by the Contractor, a through-wall removable tie system approved by the Contractor may be used.

Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

Form ties shall be factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection and to prevent spilling concrete upon removal. Provide units which shall leave no metal closer than 1 ½ inches (3.81 cm) to surface.

Provide ties which, when removed, leave holes no larger than 7/8 inch (2.22 cm) or less than ½ inch (1.27 cm) in diameter in concrete surface.

Form ties encased in concrete shall be designed so that after removal of the projecting part, no metal shall be within 1 inch (2.54 cm) of the face of the concrete. That part of the tie to be removed shall be at least ½ inch (1.27 cm) diameter and 1 inch (2.54 cm) long. Form ties in concrete exposed to view shall be the cone-washer type equal to the Richmond "Tyscru". Through-bolts or common wire shall not be used for form ties.

2.6 FABRICATION.

2.6.01 Forms. Use forms that conform to ACI 347. Fabricate with facing materials that produce the specified tolerance requirements of Article 1.02.B of this Section; produce true surfaces, sharp corners and true lines; and are free of offsets, ridges, bulging, waves and concave or convex areas.

2.6.02 Layout. Use regular and uniform pattern; long dimension of panels vertical; joints horizontal, vertical and aligned; form ties uniformly spaced and aligned in horizontal and vertical rows.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Erect, support, brace, and maintain formwork to support vertical, lateral, static, and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position. Maintain formwork construction tolerances and surface irregularities complying with the following ACI 117 limits:

Provide Class A tolerances for concrete surfaces exposed to view.

Provide Class C tolerances for other concrete surfaces.

Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts and other features required in the work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent cement paste from leaking.

Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. provide kerfs in wood inserts for forming keyways, reglets, recesses and the like for easy removal.

Provide temporary openings for clean-outs and inspections where interior area of formwork is inaccessible before and during concrete placement. Securely brace temporary openings and set tightly to forms to prevent losing concrete mortar. Locate temporary openings in forms at inconspicuous locations.

Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

Edges of all form panels in contact with concrete shall be flush within 1/32 inch (0.8 mm) and forms for plane surfaces shall be such that the concrete will be placed within 1/16 inch (1.6 mm) in 4 feet (1.22 m). Forms shall be tight to prevent the passage of mortar water and grout.

Forms for walls shall have removable panels at the bottom for cleaning, inspection, and scrubbing-in of bonding paste.

Molding or bevels shall be placed to produce ½ inch (1.27 cm) chamfer on all exposed projecting corners, unless otherwise shown on the Drawings. Similar chamfer strips shall be provided at horizontal and vertical extremities of all wall placements to produce "clean" separation between successive placements.

Forms shall be sufficiently rigid to withstand vibration and to prevent displacement of sagging between supports and constructed so the concrete will not be damaged by their removal. The Contractor shall be entirely responsible for their adequacy.

Forms, including new pre-oiled forms, shall be oiled before reinforcement is placed with an approved non-staining oil or liquid form coating not having a paraffin base.

3.1.02 Placement. Forms shall be sufficiently tight to prevent loss of mortar from the concrete, set true to the lines and elevations indicated on the Plans, tied and braced to remain true during and after concrete placement within tolerances of this Section. The Engineer may at any time condemn any section or sections of forms found deficient in any respect, and such form shall be promptly removed and replaced.

No wooden spreaders shall be allowed to remain in the concrete. No metal shall be within 1 inch of any surface.

Place chamfer strips in forms to bevel all corners, edges, joints and other structural elements exposed to view, including use of dummy chamfer and false joints to provide neat and uniform appearance. Exposed corners and edges shall have 1" x 1" (2.54 cm x 2.54 cm) – 45 degrees chamfer, unless otherwise indicated on the Plan.

Provide temporary openings at the base of wall forms and at the other points where necessary to facilitate cleaning and inspection immediately before depositing concrete.

Secure wedges and embedded items into position for final alignment.

Forms for keyways shall be prepared in advance of pouring concrete. Keyway forms in slab edges and vertical wall joints shall be rigidly secured in place before the concrete is poured. Forms for keyways for horizontal joints in walls may be placed at the conclusion of the pour, but proper provision shall be made for obtaining and holding the full depth and form of the keyway.

Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before placing concrete. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

During cold weather remove ice and snow from within the forms. Do not use deicing salts. Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosed areas.

Obtain approval before framing openings in structural members, which are not indicated on Drawings.

Install waterstops continuous without displacing reinforcement. Install waterstop a minimum of 2 inches clear of reinforcing steel. Tie through hog rings or grommets to reinforcing steel.

3.1.03 Adjustment of Forms. Positive means of adjustment should be provided to permit realignment or readjustment of shores if excessive settlement occurs.

A pair of wedges may be used at the top or bottom of shores, but not at both ends, to facilitate vertical adjustment, to correct uneven settlements, or to facilitate dismantling of the formwork.

Screw jacks for pipe shores or scaffold-type shoring may be used at both top and bottom so long as they are secured by the shore or scaffold leg against loosening or falling out, to avoid lateral deflections.

During and after concrete placement, but before initial set of the concrete, the elevations, camber and plumbness of formwork systems shall be checked, using telltale devices. Appropriate adjustments shall be promptly made where necessary. If, during construction, any weakness develops and the formwork shows any undue settlement or distortion, the work shall be stopped, the affected construction removed if permanently damaged and the formwork strengthened.

3.1.04 Removal of Forms. Provide commercial formulation form release agent with a maximum of 0.047 oz./gal. (350 mg/ltr) volatile organic compounds (VOCs) that will not bond with, stain or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

Forms, wedges or shoring shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all superimposed dead, temporary construction and live loads. When forms or shoring are removed, there shall be no excessive deflection or distortion of the concrete. Forms shall be removed in an orderly fashion; with care to avoid surface gorging, corner or edge breakage, or other damage or injury to concrete surface or physical property; and without impact or shock, to permit the concrete to carry its share of the loads gradually and uniformly. Form removal shall not impair the safety and serviceability of the structure or concrete members.

Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees F (10 degrees C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.

Formwork supporting weight of concrete, such as beam soffits, joists, slabs and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

Forms and shoring in the formwork shall not be removed without the approval of the Engineer. The minimum in-place times are for ordinary conditions and represent cumulative number of days, not necessarily consecutive, after the concrete was placed, during which the temperature of the air surrounding the concrete is above 50 degrees F (10 degrees C). The times may be increased or decreased as directed by the Engineer, dependent on air temperatures, cement type, concrete additives or other conditions of the work in accordance with ACI 347.

Submit calculations based on in-situ concrete strength and modulus at the time of form removal, to demonstrate that the fresh concrete can sustain all construction loads that act upon it without over-stress and excessive deformation.

3.1.05 Reshoring. When removing forms before structural members are strong enough to carry dead load and/or construction loads, reshores shall be installed to assure safe distribution of loading. Reshoring operations shall be planned in advance and shall be subject to the Engineer’s review. During reshoring, no construction loads shall be permitted on the new construction. Reshores shall be placed as soon as practicable after form removal, but in no case later than the end of the working day on which form removal occurs, and shall remain in place until the concrete has acquired the required strength.

3.1.06 Reusing Forms. Clean and repair surfaces of forms to be reused in the work. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. All surfaces of forms and embedded materials shall be cleaned of any mortar from previous concreting and of all other foreign material or water before coating is placed in them.
When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use patched forms for exposed concrete surfaces except as acceptable to Engineer.

End of Section

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SCOPE. This section includes reinforcing steel bars, welded wire fabric and associated accessories for cast-in-place concrete.

1.2 GENERAL

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

ACI SP-66, “ACI Detailing Manual”

ACI -315R “Manual of Engineering and Placing Drawings for Reinforced Concrete Structures”.

ACI 301, “Specifications for Structural Concrete.”

ACI 318, “Building Code Requirements for Reinforced Concrete, and Commentary”

ACI 350, “Environmental Engineering Concrete Structures.”

ASTM (American Society for Testing Materials) A82, “Steel Wire, Plain, for Concrete Reinforcement.”

ASTM A185, “Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.”

ASTM A496, “Steel Wire, Deformed, for Concrete Reinforcement.”

ASTM A497, “Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.”

ASTM A615/A615M, - “Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.”

ASTM A706/A706M, “Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.”

ASTM A775/A775M, “Epoxy-Coated Reinforcing Steel Bars.”

AWS D1.4, "American Welding Society, Structural Welding Code, Reinforcing Steel."

ASTM D3963/D3963M, "Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars."

1.3 QUALITY ASSURANCE

1.3.01 Codes and Standards: Comply with the CRSI Manual of Standard Practice, except where requirements of the contract documents or of governing codes and governing authorities are more stringent.

1.3.02 Testing Agency Services. Employ, at contractor's expense, an independent testing agency acceptable to the Engineer to perform specified tests, which include the testing of existing reinforcing steel as required, and other services required for quality assurance. Testing agency shall meet ASTM E329 requirements.

1.3.03 Fabrication. Materials for which shop drawings are required are not to be fabricated before approval of the drawings by the Engineer. Tolerances shall conform to ACI SP-66.

All reinforcing steel shall be free from defects and bends not shown on the drawings.

1.3.04 Welding. When welding is indicated, specified, or authorized by Engineer, then reinforcement, procedures, and welding shall conform to requirements of AWS D1.4.

All welding shall be performed by qualified operators, certified within the past 12 months and shall conform to requirements of AWS D1.4.

All bars shall be of the shape, size, class and grade of steel specified and as shown on the Drawings, and each bar shall have at all points a net section not less than that of plain round or square bars of corresponding size.

All reinforcing bars to be bent in the field or in the shop shall be bent cold to the shapes and dimensions shown on the Drawings or as specified herein. Bends shall be made in accordance with the requirements of the current "Manual of Standard Practice for Reinforced Concrete Construction" published by the Concrete Reinforcing Steel Institute.

Steel shall not be bent or straightened in a manner injurious to the material. Bending of reinforcing steel by heating will not be permitted. Bent up bars in beams and slabs shall be bent at an angle of 45 degrees unless otherwise shown on the Drawings.

Steel appreciably reduced in section shall be rejected.

1.3.05 Fabricating and Placing Tolerances. Bars used for concrete reinforcement shall be fabricated in accordance with the fabricating tolerances given in ACI 315. Bars shall be placed to the following tolerances:

Clear distance to formed surfaces	± ¼ inch (6.4 mm)
Minimum spacing between bars	± ¼ inch (6.4 mm)
Top bars in slabs and beams:	
Members 8 inches (20.32 cm) deep or less	± ¼ inch (6.4 mm)
Members more than 8 inches (20.32 cm) but not over 2 feet (60.96 cm) deep	± ½ inch (1.27 cm)
Members more than 2 feet (60.96 cm) deep	± 1 inch (2.54 cm)
Crosswise of members	spaced evenly within 2 inches (5.08 cm)
Lengthwise of members	± 2 inches (5.08 cm)

Bars may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, the resulting arrangement of bars shall be subject to acceptance.

1.4 SUBMITTALS

1.4.01 Drawings and Data. Reinforcing bar schedules and detail shop drawings showing complete details as to size, length, weights, arrangement and bending shall be submitted by the Contractor, a complete schedule of reinforcement chairs, supports, saddles, spacers, and other accessories shall be included as provided in the Specification herein. No reinforcement shall be cut, bent or fabricated before these schedules and/or drawings are approved by the Engineer.

General placement drawings showing the location of pieces detailed shall be submitted with the detail drawings and schedules. Show construction and expansion joints. Show details of bar supports and spacers including types, sizes, spacing, sequence and support bars. Show marking for each reinforcement item.

1.4.02 Certificates. Submit certified mill test reports for each shipment of reinforcement showing that steel complies with applicable specification. Reports shall identify specific lots in shipment and submitted prior to use of reinforcement in work.

Submit chemical composition of reinforcement steel, including ladle analysis to stating percentage of carbon, phosphorous, manganese and sulfur present in steel.

Submit Welder’s certification in accordance with AWS D1.4 prior to welding when welding is indicated, specified or approved by Engineer.

1.5 DELIVERY, STORAGE AND HANDLING. Ship reinforcement and accessories to work site with items of same size and shape fastened in bundles tagged and marked in accordance with the code of standard practice in the current "Manual of Standard Practice for Reinforced Concrete Construction" published by the Concrete Reinforcing Steel Institute. Identify each bundle using wired-on metal identification tags indicating size and mark.

Store reinforcement and accessories above ground on platforms, skids or other supports and protect from weather at all times with suitable coverage. It shall be stored in an orderly manner plainly marked to facilitate inspection and checking. Labor and other assistance shall be furnished to the Engineer as may be required to check the steel as it is being stored or after storage on the site.

Protect reinforcement from rusting, deforming, bending, kinking and other damage.

PART 2 – PRODUCTS

2.1 MATERIALS.

2.1.01 Steel Reinforcing Bars. Newly rolled deformed billet-steel bars for concrete reinforcement shall conform to ASTM A615, Grade 60, unless otherwise indicated. Bar sizes No. 3 (3/8 inch (9.5 mm)) and larger shall be deformed.

When welding of reinforcement is indicated, specified, or approved by the Engineer, reinforcement must be ASTM A706. Welding of epoxy-coated reinforcement is not permitted.

When any portion of a bar requires epoxy coating, the entire bar shall be coated in accordance with ASTM D3963.

Reinforcing shall be mill and cold bent. Conform to dimensions indicated and meet the requirements of ACI SP-66.

Reinforcing steel, post tensioning strands and pre-stressing strands shall be in accordance with MDOT Standard Specification for Construction.

2.1.02 Tie Wire. Tie wire shall be of mild steel or annealed iron, 16 gage (1.6 mm) or heavier.

For epoxy coated reinforcement, use plastic coated wire, and epoxy coated wire or molded plastic clips.

2.1.03 Supports for Reinforcement. Use bolsters, chairs, spacers and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar-type supports complying with CRSI specifications.

For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

For exposed to view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are protected by plastic (CRSI, Class 1) or stainless steel (CRSI, Class 2).

For epoxy coated steel reinforcement, bar chairs shall be plastic coated wire, epoxy coated wire or plastic.

Bar spacers in contact with exposed surfaces shall be plastic protected in conformance with ACI SP-66 (Class 1 - Maximum Protection).

2.1.04 Welded Wire Fabric. Conform to ASTM A185. Gage and spacing shall be as indicated.

2.1.05 Stainless Steel. Conform to Type 316.

2.1.06 Mechanical Couplers. Mechanical couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.

Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.

Hot –forged sleeve type couplers shall not be used. System shall possess a current and valid International Code Council Evaluation Service Report. Acceptable

Manufacturers: Erico Lenton, Form Saver; Dayton Richmond, DB-SAE; or as approved.

2.1.07 Dowel Adhesive System. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer’s instructions. The embedment depth of the bar shall be per manufacturer’s recommendations, so as to provide a minimum allowable bond strength that is equal to 125 percent of the yield strength of the bar, unless noted otherwise on the Drawings. The adhesive system shall be “Sikadur Injection Gel” as manufactured by Sika Corporation, “Epcon System” as manufactured by ITW Ramset/Redhead, or “HIT-HY 200 Injection Adhesive Anchor System” as manufactured by Hilti, Inc. Engineer’s approval is required for use of this system in locations other than those shown on the Drawings.

PART 3 - EXECUTION

3.1 PREPARATION. Before placing in form, thoroughly clean reinforcement and accessories free of mortar, oil, dirt, loose mill scale, loose or thick rust, and coatings of any character that would destroy or reduce the bond with the concrete.

3.2 INSTALLATION.

3.2.01 Placement. Accurately place reinforcing bars and secure in position using tie wire with ends pointed away from forms.

Reposition bars as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, the resulting arrangement of bars is subject to acceptance by Engineer. Place required number of bars.

Use precast concrete or metal chairs, bolsters, spacers, anchors, saddles, ties, light structural frames of approved shape and dimensions and other approved devices of sufficient strength to resist crushing under load in accordance with ACI SP-66. Do not use metal chairs which extend to such surfaces as concrete, stones, and brick chips. Do not use wood block supports.

Use precast concrete bar support blocks for foundation mats, base slabs, and slabs on grade.

Placing bars on layers of fresh concrete as the work progresses, and adjusting bars during the placement of concrete is not permitted.

Place bar laps in contact and tie securely, or space transversely apart to permit embedment of entire surface of each bar in concrete. Length of laps for bars shall conform to requirements of ACI 318, except as otherwise indicated.

Reinforcement or other fixed metal items shall not be continuous through expansion joints. Provide reinforcement clearance of two inches from each face of expansion joint.

Do not field bend bars including bars partially embedded in concrete unless indicated or authorized by Engineer. Do not straighten or bend in manner injurious to steel, epoxy-coating or concrete.

Do not place bars that have kinks and bends other than shown on approved shop drawings. Reject and remove such damaged bars and replace at no additional compensation.

Do not use heat to bend or straighten reinforcing steel.

Welding of reinforcing bars shall be permitted where indicated or as otherwise directed by Engineer. Such welding shall be in accordance with AWS D1.4.

Welding reinforcing steel shall be done only by operators certified in accordance with AWS D1.4.

Tack welding to, or of, reinforcement is prohibited.

Paint reinforcement which is to be exposed for more than 90 days with coat of neat cement grout to prevent rust formation.

In case there is a delay in placing concrete after the steel has been placed, the steel shall be reinspected and, when necessary, recleaned prior to placement of the concrete.

The minimum center-to-center distance between parallel bars shall be two and one-half (2 ½) times the diameter of the bars. End-hooked bars shall have a minimum center to center spacing of two (2) times the diameter of the bars. In no case shall the clear spacing between bars be less than one (1) inch (2.54 cm), nor less than one and one-third (1/3) times the maximum size of the coarse aggregate.

Relative to the face of the concrete, unless otherwise shown on the Drawings, reinforcement shall be placed as follows:

For concrete surfaces exposed to sewage or sewage atmosphere, and for concrete poured on earth subgrade, the clear distance from the main steel to surface shall be

3 inches (7.62 cm). The clear distance from the main steel to other surfaces shall be 2 inches (5.08 cm).

Temperature or shrinkage steel, relative to the main or flexure steel, shall be placed away from the concrete surfaces.

The clear distance between reinforcing steel and the face of the concrete shall be maintained at all points in order that the designed strength of the structure shall not be reduced.

All reinforcement shall be supported and fastened together to prevent displacement by construction loads or the placing of concrete beyond the tolerances of Paragraph 1.4.05. Unless otherwise indicated in the project specification, reinforcement supported from the ground shall rest on precast concrete blocks not less than 4 inches square, and having a compressive strength equal to the specified compressive strength of the concrete being placed. Other means of support may be used if acceptable to the Engineer.

Reinforcement supported from formwork shall rest on bar supports and spacers made of concrete, metal, plastic or other acceptable materials. Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories within ½ inch (1.27 cm) of the concrete surface shall be non-corrosive or protected against corrosion.

Welded wire fabric designated as load-carrying reinforcement shall be overlapped wherever successive mats or rolls are continuous in such a way that the overlaps shall be at least two full meshes. It shall be supported as required for reinforcing bars.

Welded wire fabric not specifically designated as load-carrying reinforcement shall be overlapped wherever successive mats or rolls are continuous in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than 2 inches (5.08 cm). The fabric shall extend across supporting beams and walls and to within 4 inches (10.16 cm) of concrete edges. It may extend through contraction joints. It shall be adequately supported during placing of concrete to insure its proper position in the slab either by laying the fabric on a layer of the fresh concrete of the correct depth before placing the upper layer of the slab.

Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To insure proper placement, templates shall be furnished for all column dowels.

All splices not indicated on the contract documents shall be subject to acceptance. Mechanical connections for reinforcing bars may be used subject to acceptance.

Do not field-cut reinforcement without Engineer's permission.

Unless permitted by the Engineer, reinforcement shall not be bent after being embedded in hardened concrete.

Clean reinforcement of loose rust, mill scale, ice, earth, and other materials which affect bond with concrete.

3.2.02 Splicing. Reinforcement shall not be spliced at points other than shown on the Drawings except with the approval of the Engineer. The main or flexural steel shall not be tied together but shall be staggered so that the distance between adjacent bars in one-half the minimum nominal spacing shown on the Drawings or as specified herein.

Provide reinforcement continuous through construction joints except as otherwise indicated. Do not splice reinforcement steel in mats, slabs, beams, girders and walls at points of maximum stress unless otherwise indicated. Lap splice wire-mesh reinforcement at least two full meshes; stagger to avoid continuous laps in either direction and wire securely.

Mechanical splices shall be used only where shown on the Drawings or when approved by the Engineer.

3.2.03 Dowels. Dowels and exposed reinforcing bars intended for bonding with future construction shall be protected from corrosion in a manner approved by the Engineer. All dowels shall be placed before the concrete is placed. The insertion of dowels after the concrete has been placed will not be permitted.

End of Section

SECTION 03250

CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section includes joint fillers, joint sealants, waterstops, slab isolation systems, and miscellaneous embedded items in concrete.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing Materials), D994 - “Performed Expansion Joint Filler for Concrete.”

ASTM D1190, “Concrete Joint Sealer, Hot – Applied Elastic Type.”

ASTM D1751, “Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types).”

ASTM D1752-84, “Performed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.”

ASTM 03405, “Joint Sealants, Hot-Applied, for concrete and Asphalt Pavements.”

ASTM 03406, “Joint Sealants, Hot-Applied, Elastomeric – Type for Portland Cement Concrete Pavements.”

Corps. of Engineers Spec. CRD-C572-74, Specification for Polyvinylchloride Waterstop.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit a schedule showing sequence of concrete pouring and indicate locations of proposed construction and expansion joints. This schedule is subject to approval of the Engineer.

1.3.02 Test Reports. Submit certified manufacturer’s affidavits for expansion joint filler, joint sealant, slab isolation systems, and waterstops to verify compliance with the applicable Specifications.

1.4 DELIVERY, STORAGE, AND HANDLING. Deliver concrete accessories in manufacturer's packaging including installation instructions. Store materials in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Joint Filler. Preformed Expansion Joint Filler (Bituminous Type) shall comply with ASTM D994.

Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) shall comply with ASTM D1751.

Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Concrete shall comply with ASTM D1752.

2.1.02 Joint Sealer. Expansion Joint Seal System shall consist of a pre-molded neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive and pressurized during the adhesive cure time.

The expansion joint sealing system shall be "Hydrozo/Jeene Structural Joint Sealing System" by Hydrozo/Jeene, Inc. or approved equal.

Joint Sealants, Hot-Poured, For Concrete and Asphalt Pavement shall comply with ASTM D3405.

Joint Sealants, Hot-Poured, Elastomeric Type, for Portland Cement Concrete Pavements shall comply with ASTM D3406.

2.1.03 Contraction or Control Joint Inserts. Contraction joint inserts shall be Transverse-Control Joints by Greenstreak Plastic Products or approved equal.

2.1.04 Polyvinyl Chloride (PVC) Waterstops. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.

Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.

The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.

The required minimum physical characteristics for this material are:

Tensile strength - 1,750 psi (ASTM D-638).

Ultimate elongation - not less than 280% (ASTM D-638).

No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.

PVC waterstops shall be as manufactured by Greenstreak Plastics Products or approved equal.

All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

2.1.05 Bentonite Waterstops. Bentonite waterstops shall be 1-inch side Volclay Waterstop-RX by the American Colloid Company, Swellstop by Greenstreak Plastic Products, or Bluestop by Vinylex Corporation.2.1.06 Expanding Rubber Waterstop. Expanding rubber waterstop shall be Adeka Ultra Seal by Asahi Denka Koygokik, Hydrotite by Greenstreak Plastic Products.

Waterstops shall be a chemically modified natural rubber product with a hydrophilic agent.

2.1.07 Waterstop Adhesive. Adhesive between waterstops and existing concrete shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

2.1.08 Expansion Joint Material. Pre-molded expansion joint material shall be non-extruding, and shall be of the following types:

Type I -Sponge rubber, conforming to ASTM D1752, Type I.

2.1.09 Epoxy Bonding Agent. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH.

2.1.10 Epoxy Resign Binder. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J.

2.1.11 Vapor Barrier. Vapor barrier shall be 8-mil polyethylene, manufactured in accordance with ASTM C171 and shall be placed on top of 4 inches minimum of compacted structural fill stone. A 3 inch minimum layer of sand shall be placed on top of the vapor barrier prior to casting the floor slabs.

2.1.12 Slab Isolation Systems. System shall consist of isolation pads and low density material in roll form designed to safely withstand a minimum imposed live load of 1,500 psf (7.324 kg/m^2) in all areas. Pads shall have satisfactorily passes WMATA Section 3.49, Dynamic Test for Isolator Permanence.

PART 3 – EXECUTION

3.1 INSPECTION. Inspect the locations and surfaces to receive joint filler, joint sealer, waterstops, slab isolation system, or miscellaneous embedded items and correct defects or conflicts which will affect the proper performance of the item to be placed.

3.2 PREPARATION. All accessories to be embedded into concrete shall have contact surfaces free of dirt, curing compound, protrusions of hardened concrete or any other foreign material which would affect bond with concrete.

3.2.01 Sequencing. The Contractor shall sequence installation of miscellaneous embedded items with the work of Master Specification Sections in Division 3, Concrete.

3.2.02 Joint Sealants. Prime surfaces in accordance with manufacturer's recommendations.

3.2.03 PVC Waterstops. PVC waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.

Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval.

Splices in PVC waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.

All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.

3.2.04 Bentonite, and Expanding Rubber Waterstops. Waterstops shall be installed only where shown on the Drawings.

Waterstops shall be installed in strict accordance with manufacturer's recommendations

3.2.05 Waterstop Adhesive. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.

Adhesive shall be used where waterstops are attached to existing concrete surfaces.

3.2.06 Installation of Expansion Joint Material and Sealants. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.

All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.
Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and

no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.
Type 2 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 1 or Type 7 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.

Type 1 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.

Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

3.2.07 Expansion Joint Seal. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

3.2.08 Contraction or Control Joint Inserts. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.

For contraction joints in walls, inserts shall be secured in place prior to casting wall.

Inserts shall be installed true to line at the locations of all contraction joints as shown on the Drawings.

Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.

Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

3.2.09 Epoxy Bonding Agent. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.

Bonding surface shall be clean, sound and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.

Application of bonding agent shall be in strict accordance with manufacturer's recommendations.

Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

3.2.10 Epoxy Resin Binder. Epoxy resin binder shall be used to seal all existing reinforcing steel cut and burned off during demolition operations. Exposed reinforcing steel bars shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

3.3 INSTALLATION.

3.3.01 Joint Fillers. Details, including materials and methods of installation of joint fillers shall be as indicated on the Plans and as directed in the field.

3.3.02 Joint Sealants. Joints shall not be sealed when the sealant, air or concrete temperature is less than 40 degrees F (4 degrees C). Bond breaker and backup material shall be installed where required as indicated on the Plans or manufacturer's recommendations.

3.3.03 Waterstops. Shall be maximum practicable length to minimize joints.

Shall be positioned as indicated on the Plans in a manner to permanently retain flexibility.

Splices in running lengths or at intersections shall be performed by heat sealing in accordance with manufacturer's recommendations.

Reform splices with a remolding iron with ribs or corrugations to match the pattern of the waterstops. When cooled and bent by hand in as sharp an angle as possible, the splice shall show no sign of separation.

Provide support and protection of the waterstops during the progress of the work. Any waterstop punctured or damaged shall be replaced or repaired at the Contractor's expense. The concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.3.04 Slab Isolation Systems. The installation of all slab isolation system materials shall be per manufacturer's specifications and as indicated on the plans.

After installation of the isolation materials and pouring forms, the system shall be protected with two layers of 6 mil (.02 mm) polyethylene film overlapped and taped at all seams. The perimeter and all penetrations shall be caulked with polyurethane sealant after the concrete has been cured.

3.3.05 Miscellaneous Embedded Items. All sleeves, inserts, anchors, and other embedded items required for adjoining Work or for its support shall be placed prior to concreting. Embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into voids.

End of Section

SECTION 03251

CONSTRUCTION AND EXPANSION JOINTS

PART 1 - GENERAL

1.1 SCOPE. This section includes construction and expansion joint requirements.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C920, "Elastomeric Joint Sealants."

ASTM D994, "Preformed Expansion Joint Filler for Concrete (Bituminous Type)."

ASTM D1751, "Performed Expansion Joint Filler for Concrete Paving and Structural Construction (Non Extruding and Resilient Bituminous Types)."

ASTM D1752, "Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction."

ASTM D2628, "Performed Polychloroprene Elastomeric Joint Seals for Concrete Pavements."

ASTM D2835, "Lubricant for Installation of Performed Compression Seals in Concrete Pavements."

Corps. of Engineers Spec. CRD-C572-74, Specification for Polyvinylchloride Waterstop.

1.3 QUALITY ASSURANCE. Do not add or relocate construction and expansion joints without written approval of Engineer.

Cast slabs and beams monolithically, without horizontal joints unless otherwise indicated.

Do not use horizontal joints in footings and foundation mats unless otherwise indicated.

Provide concrete construction and expansion joints in fills and toppings at the same location as the construction and expansion joints in the supporting concrete.

1.4 SUBMITTALS. Prior to delivery of materials, submit the following for approval:

1.4.01 Drawing and Data. Submit product data for all materials including location where product is to be used. Submit manufacturer's application and installation instructions.

1.4.02 Certifications. Submit certification that materials meet the specifications.

1.4.03 Samples. Submit samples of water stops and joint fillers.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver joint materials in manufacturer's packing including installation instructions. Store materials in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Joint Compounds. Joint compound for joints in horizontal or nearly horizontal surfaces: ASTM C920, Type S or M, Grade P, Class 25, Use T in pedestrian and vehicular traffic areas, and Use NT in non-vehicular areas. Use preformed joint seals where indicated.

Joint compound for joints in walls shall comply with ASTM C920, Type S or M, Grade NS, Class 25. Compounds abutting each other shall be compatible. Compounds in tanks shall be suitable for continuous submergence in liquids.

Preformed Polychloroprene Elastomeric Joint Seal (compression seal): Vulcanized elastomeric compound using polychloroprene as the only base polymer. Use in expansion joints where indicated and conform to ASTM D2628.

Lubricant for installation of Elastomeric Joint Seal shall be single-component polychloroprene compound; ASTM D2835.

2.1.02 Bond Breaker for Joint Compounds. Polyethylene tape, coated paper, metal foil or similar type materials.

2.1.03 Back-Up Material for Joint Compounds. A 100 percent closed-cell material, compressible, non-shrink, non-reactive with joint compound, and non-absorbent. Extruded butyl or polychloroprene foam rubber is acceptable. Material impregnated with oil, bitumen, or similar substances is not acceptable.

Back-up material shall be compatible with joint compound and have same expansion/contraction capability as compound.

2.1.04 Pre-Molded Joint Filler. Unless otherwise specified, pre-molded joint filler shall comply with ASTM D1752, Type I or Type II, ASTM D994, or ASTM D1751.

Furnish joint filler with thickness equivalent to joint width indicated and of suitable length and width.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 Construction Joints. Provide keys for key grooves with width one-third the thickness of the thinner member in which the key is placed and a key depth of 1-1/2 in (3.81 cm), except as otherwise indicated.

Use slightly tapered key groove forms to permit form removal without damage to groove after concrete has cured. Do not remove key groove forms until after concrete has cured.

Center waterstops in construction joints except as otherwise indicated.

The PVC strip shall be embedded one-half its width in the poured concrete at the construction joint. The exposed half width of strip shall be adequately protected against damage and shall be cleaned and repaired, if needed, prior to being embedded in the next adjacent pour. The strip shall be placed and firmly secured in relation to the construction joint and sewer wall or structure as detailed in the Drawings. In lieu of the detail on the Drawings, the strip may be placed and secured at the construction joint in accordance with details submitted by the Contractor and approved by the Engineer.

The bentonite/butyl rubber waterstop shall be installed at the locations as indicated on the Drawings and per the manufacturer's recommendations. In the event that a conflict occurs between the Drawings and the manufacturer's recommendations, bring conflict to Engineer's attention for approval prior to proceeding with installation.
Clean key groove free of latice, curing compound, foreign materials, protrusions of hardened concrete; roughen; and blow out debris and dust with oil-free compressed air.

Continue reinforcement across and perpendicular to construction joints, unless specifically indicated otherwise.

3.1.02 Expansion Joints. Provide expansion joints indicated on drawings. Center waterstops in expansion joints except as otherwise indicated.

3.1.03 Polyvinylchloride Waterstops. The PVC strip shall be constructed as a continuous one-piece waterstop to produce water tightness. Any required splice shall be in strict accordance with the manufacturers recommended method.

Make all splices on a bench following manufacturer's splicing procedures and instructions. Use miter guide and portable power saw to cut spliced ends. Maintain continuity of characteristic features of waterstop cross section (ribs, center bulb, etc.)

Make splices by heat sealing adjacent surfaces using a thermostatically controlled electric heat source in accordance with manufacturer's printed instructions. Reform waterstop at splices using a remolding iron having pattern matching waterstop. After splice has cooled, test by hand bending flat sides of waterstop at splice to sharp bend in both directions. If splice shows any separation or lack of fusion reject splice.

Carefully and correctly position waterstop to form continuous watertight diaphragm in joint to avoid leakage. Support and protect waterstop. Clean waterstop of curing compound, foreign materials, and protrusions of hardened concrete. Replace or repair damaged or punctured waterstop as directed by Engineer.

Consolidate concrete in vicinity of the waterstop during concrete placement.

3.1.04 Premolded-Joint Filler. All joints which are to be sealed shall be formed with filler. Place filler in correct position before concrete is placed against it. Prevent disturbance of or damage to joint filler. Fill expansion joint completely.

Holes or joints in the filler shall be filled with mastic to prevent the passage of mortar or concrete from one side of the joint to the other.

3.1.05 Joint Compound. Clean and dry concrete to be sealed in accordance with manufacturer’s printed instructions. Install back-up and bond breaker materials. Prime concrete, fill joint flush with joint compound of required thickness, tool to concave joint and seal, all in accordance with the joint compound manufacturer’s instructions and ASTM C920. Prevent spilling compound over adjoining surfaces. Use tape adjacent to joint if required. Remove all tape completely from concrete surface. Do not seal when compound, air, or concrete temperature is less than 40° F (4 degrees C).

3.1.06 Preformed Elastomeric Joint Seal. All joint fillers should be removed prior to installation of compression seal. Prior to installation, correct irregularities in the expansion joint face that would prevent contact between the joint seal and the joint face. Lightly sandblast the exposed joint faces until the surfaces are free of dust, dirt, curing compound, joint filler, and any other material that might prevent ready insertion and bonding of the joint seal to the concrete or stainless steel. After final cleaning and immediately prior to joint seal installation, clean the expansion joints until they are completely free of sand and water.

Ensure that the expansion joints are thoroughly clean and dry. Do not install the joint seal if the atmospheric and pavement temperatures are at or below 40° F (4 degrees F).

Lubricate and install the joint seal in accordance with the seal manufacturer’s printed instructions. Ensure that the in-place joint seal is in the upright position and free from twisting, distortion and stretching that exceed five percent. Install the joint seal to a depth of 3/16 inch (4.8 mm), plus or minus 1/16 inch (1.6 mm), from the finished surface. Ensure that butt joints and intersecting splices have full contact. Use adhesive recommended by the seal manufacturer. Remove contaminants, such as dust, grease from the seal.

3.1.07 Bentonite/Butyl Rubber Waterstops. Follow manufacturer’s recommendations for preparation and installation of bentonite/butyl rubber waterstop. Tightly butt coil ends together to form a continuous waterstop – DO NOT OVERLAP COIL ENDS. Place the maximum practical lengths to minimize coil end joints. Where required, cut coils with a sharp knife or utility blade to fit coil ends together. Make horizontal to vertical transitions by abutting coil sections together.

End of Section

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE. Provide all labor, equipment, materials and services necessary for the manufacture, transportation, placement, and curing of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.

The requirements in this section shall apply to the following types of concrete:

Class A Concrete: Normal weight concrete to be used in all cast in place structures and pavements except where noted otherwise in the Contract Documents.

Class B Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement and all other concrete appurtenant to electrical facilities unless otherwise shown or noted on the Drawings. Concrete to be used for thrust blocks, pipe trench cut-off blocks and cradles, mud-mats, and concrete fills where the preceding items are detailed on the Drawings as unreinforced. Concrete to be used as protective cover for dowels intended for future connection.

1.2 GOVERNING STANDARDS. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specification, codes, and standards refer to the most current issue available at the time of Bid.

ACI 214	Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305	Hot Weather Concreting
ACI 306	Cold Weather Concreting
ACI 308	Standard Practice for curing concrete
ACI 309	Recommended Practice for Consolidation of Concrete

ACI 318	Building Code Requirements for Structural Concrete and Commentary
ACI 350	Environmental Engineering Concrete Structures and Commentary (ACI 350R)
ASTM C 31	Standard Methods of Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 88	Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 114	Standard Test Method for Chemical Analysis of Hydraulic Cement
ASTM C 136	Standard Method for Sieve Analysis of Fine and Coarse Aggregate
ASTM C 138	Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
ASTM C 143	Standard Test Method for Slump of Portland Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 171	Standard Specifications for Sheet Materials for Curing Concrete
ASTM C 172	Standard Method of Sampling Fresh Concrete
ASTM C 192	Standard Method of Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
ASTM C 494	Standard Specification for Chemical Admixtures For Concrete
ASTM C 595	Standard Specification for Blended Hydraulic Cements
ASTM C 618	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
ASTM C 989	Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C1260	Standard Test Method for Potential Alkali Activity of Aggregates (Mortar-Bar Method)
MDOT	Michigan Department of Transportation Latest Edition of Standard Specifications for Construction
AASHTO T26	Quality of Water to be used in Concrete

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit the following in accordance with Specifications herein:

Sources of all materials and certifications of compliance with specifications for all materials.

Aggregate test results showing compliance with required standards, i.e., sieve analysis, aggregate soundness tests, etc.

Manufacturer's data on all admixtures stating compliance with required standards.

Concrete mixture designs and test data shall be submitted for review by the Engineer with a written request for approval. No concrete shall be placed until the Contractor has received such approval in writing. Each mixture report shall include:

Slump on which design is based.

Total gallons of water per cubic yard.

Brand, type, composition, and quantity of cement.

Brand, type composition, and quantity of fly ash.

Brand, type, composition, and quantity of microsilica

Specific gravity and gradation of each aggregate.

Ratio of fine to total aggregates.

Weight (surface dry) of each aggregate per cubic yard.

Brand, type, ASTM designation, active chemical ingredients, and quantity of each admixture.

Air content.

Compressive strength based on 7-day and 28-day compression tests.

Time initial set.

Submit reports of the sampling and testing of slump, air content and strength performed.

Submit reports of nondestructive, core and/or liquid retention testing required for acceptance of concrete in place.

Submit Shop Drawings showing the location of all joints. Included shall be a schedule of the concrete pouring. The location of joints and pouring schedule shall be subject to approval by the Engineer.

Delivery Tickets: Furnish to Engineer copies of all delivery tickets for each load of concrete delivered to the site, see Article 3.2.B.6.

1.4 QUALITY ASSURANCE. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.

Trial concrete mixes shall be tested when required in accordance with Article 3.10 at no additional cost to the Owner.

Field quality control tests, as specified herein, unless otherwise stated, will be performed by a testing laboratory employed by the Contractor. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Hydraulic Cement.

Portland Cement:

Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided fly ash is also included in the mix in accordance with Specifications herein.

For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of NA2O plus 0.658 times the percentage of K2O) shall not exceed 0.40% unless aggregates to be used meet the requirements for non-reactivity with alkalies stated in Article 2.4.

For concrete mixed with Portland Cement and an appropriate amount of fly ash, the total alkalies in the Portland Cement (calculated as the percentage of NA2O plus 0.658 times the percentage of K2O) shall not exceed 0.85% unless aggregates to be used meet the requirements for non-reactivity with alkalies stated in Article 2.4.

Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.1.02 Fly Ash.

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Fly ash shall meet the requirements of ASTM C 618, except that the loss on ignition shall not exceed 4%. The available alkalis in the fly ash shall not exceed 1.5% as specified in ASTM C 618. Fly ash shall also meet the optional physical requirements for uniformity as shown in ASTM C 618.

Where fly ash is included in the concrete mix to waive the 0.4% alkali requirement of the Portland Cement, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set so that the mean mortar bar expansion of the cement-fly ash mix shall be 0.08% or less when tested at 16 days in accordance with ASTM C 1260. The Portland Cement and aggregates used in the mix for this test shall be the Portland Cement and aggregates submitted for use on the job.

2.1.03 Water. Potable water approved by the State Department of Public Health may be used without testing.

For water requiring testing, the tests shall be conducted in accordance with AASHTO T26 and meet the following requirements:

Total Solid Mater, max. ………… 0.30%

Organic Matter, max. …………… 0.05%

Alkalinity-acidity ……………….. neutral to litmus

2.1.04 Aggregates. All aggregates used in normal weight concrete shall conform to ASTM C 33.

Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.

General Requirements: Washing will be required to eliminate the dust, clay, or silt coating. Aggregates, which have been washed, shall not be used sooner than 24 hours after washing, unless approved by the Engineer.
Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances. Fine Aggregate shall be MDOT aggregate 2NS. Fine aggregates shall conform to MDOT Specification 902.09 and the Grading Requirements in Table 902.4.

Coarse Aggregate shall be gravel or crushed rock conforming to MDOT Class 6AA meeting the requirements of MDOT paragraph 902.03 as well as tables 902-1 and 902-2.

Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using magnesium sulfate.

When aggregates, which are non-reactive with alkalis, are desired in order to waive the alkali content requirement of cement as stated in herein, the following tests shall be performed:

A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Aggregates containing more than the following quantities of constituents shall be considered potentially reactive:

a. Optically strained, microfractured, or microcrystalline quartz exceeding 5.0%.

b. Chert or chalcedony exceeding 3.0%.
c. Tridymite or cristobalite exceeding 1.0%.

d. Opal exceeding 0.5%.

e. Natural volcanic glass in volcanic rocks exceeding 3.0%.

Aggregate shall be evaluated by ASTM C-1260 Aggregate sources that exhibit mean mortar bar expansions at 16 days greater than .08% shall be considered potentially reactive. Tests shall be made with cement proposed for use on the job.

Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

No aggregates that have become intermixed prior to proportioning shall be used. Sufficient aggregate shall be available at the site to preclude the possibility of damaging delays while placing the concrete.

2.01.05 Admixtures. Provide admixtures produced by established, reputable manufacturers, and used in compliance with the manufacturer's printed instruction. Do not use admixtures which have not been incorporated and tested in accepted mixes, unless otherwise authorized in writing by the Engineer.

Air Entraining Admixtures: ASTM C 260

Product and Manufacturer: Provide one of the following:

SIKA AER, as manufactured by Sika Corporation.

MB-VR, as manufactured by Master Builders, Inc.

Daravair, as manufactured byt W.R. Grace & Co.-Conn.

Or equal.

Water-Reducing Admixture: ASTM C 494, Type A.

Proportion all Class “A” and Class “B” concrete with non-air entraining, normal-setting, water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. The admixture shall not contain any lignin, nitrates or chlorides added during manufacturing.

Product and Manufacturer: Provide one of the following:

Eucon WR-75, as manufactured by the Euclid Chemical Company.

Pozzolith, as manufactured by Master Builders Inc.
WRDA-15, as manufactured by W.R. Grace & Co.-Conn.

Or equal.

Do not use calcium chloride or other accelerating mixtures unless specifically permitted by the Engineer for mass concrete.

2.2 CONCRETE MIX DESIGN. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318. When trial mixes are used they shall also conform to Article 3.1 of this specification section. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.

Class A concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and ground granulated blast furnace slag contained in the mix.

Compressive strength (28-Day): 4,500 psi (for concrete mixed with only Portland Cement 4,000 psi (for concrete mixed with Portland Cement and fly ash)

Maximum water/cementitious: 0.45 materials ratio, by weight

Slump range: 4" nominal unless high range water reducing admixture is used.
3" max. before addition of high range water reducing admixture.

8" max. after addition of high range water reducing admixture.

Air Content:

All Class A concrete not otherwise noted: 6% +/- 1.5%

Class A concrete which is to receive a hardened finish (Type G in accordance with Section 03350): 3% Max

Class B concrete need not be air-entrained unless exposed to freeze/thaw cycles or as may be otherwise indicated. The minimum compressive strength (28-day) of these types of concrete shall be 2,500 psi.

PART 3 - EXECUTION

3.1 TRIAL MIX. When field experience records are inadequate to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318, or when required by the Engineer, an independent testing laboratory designated by the Contractor and acceptable to the Engineer shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batch shall be prepared using the aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

An independent testing laboratory shall observe the preparation of the trial batch, and they shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully labeled. If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

3.2 PRODUCTION OF CONCRETE. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready mix plant or from a site mixed plant. In selecting the source for concrete production the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.

3.2.01 Ready-Mixed Concrete. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.

Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, shall be checked before a further attempt to use the unit will be permitted.

Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 250 revolutions and within the time requirements stated in Article 3.03 of this Section.

Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:

Date and truck number

Ticket number

Mix designation of concrete

Cubic yards of concrete

Cement brand, type and weight in pounds

Weight in pounds of fine aggregate (sand)

Weight in pounds of coarse aggregate (stone)

Air entraining agent, brand, and weight in pounds and ounces

Other admixtures, brand, and weight in pounds and ounces
Water, in gallons, stored in attached tank

Water, in gallons, maximum that can be added without exceeding design water/cement ratio

Water, in gallons, actually used (by truck driver)

Time of loading
Time of delivery to job (by truck driver)

Signatures of inspectors at plant and site

Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.

The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

3.2.02 Site Mixed Concrete. Scales for weighing concrete ingredients shall be accurate when in use within "0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.

Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

Cement, fly ash:	+/- 1 percent
Water:	+/- 1 percent

Aggregates:	+/- 2 percent
Admixtures:	+/- 3 percent

Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period that may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.

Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.

Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete. Re-tempering or re-mixing concrete that has partially set will not be permitted.

Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.

The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.

Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

If two or more admixtures are used in the concrete, they shall be added separately.

Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.

Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94. The mixer shall be cleaned each time when not operating for more than 30 minutes.

3.3 CONCRETE PLACEMENT. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.

Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to the embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.
On horizontal joints where concrete is to be placed on hardened concrete, a slush coat of mortar 1/2-inch to 1-inch thick with slump less than 6 inches, made of the same materials as the concrete, but without the coarse aggregate, shall be worked well into the irregularities of the hard surface just ahead of the concrete placement.

All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.

When concrete arrives at the site with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cement ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.

Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated herein.

No concrete shall be deposited in any unit until the area has been completely de-watered, and not until after the CONTRACTOR has made satisfactory provisions to eliminate all possibility of water entering or flowing through the concrete while it is being poured or is taking its set.

Before depositing new concrete on or against concrete which has already been cast, it shall be roughened as required by the Engineer and thoroughly cleaned of foreign matter and laitance. It shall be saturated with water, and then cleaned. The saturated surface of the hardened concrete, including vertical and inclined surfaces, shall be slurried with a minimum 2-inch thick coating of concrete grout without coarse aggregate.

Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet.

The interior hopper slope shall be not less than 60 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five (5) times the nominal maximum size aggregate and the area of the gate opening shall be not less than two (2) square feet. The maximum dimension shall not be greater than twice the minimum dimension. The bucket gates pneumatically or hydraulically operated except for buckets larger than two, (2) cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

Conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer points and the point of placing.

Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.

Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so that the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to insure the concrete being kept level at all times.

When placing concrete that is to be exposed, sufficient illumination shall be provided in the interior of the forms so that the concrete, at places of deposit, is visible from deck and runways.

Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.

When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309. Vibrators shall be used at 18” to 30” intervals in the concrete.

Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.

The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,000 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency, size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed. All such vibrating, including methods and equipment, shall be subject to review by the Engineer.

Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.

To prevent featheredges, construction joints that are located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so that the angle between such inclined surface and the exposed concrete surface will be not less than 50°.

In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.

Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

3.4 PLACING UNDERWATER CONCRETE. No concrete shall be placed under flowing water. The concrete shall be placed by gravity flow tremies or pipelines from the mixer. The hopper and tremie pipe shall be a closed system. The bottom of the tremie shall be kept as far as practical below the surface of the placed concrete. The tremie pipe shall be large enough to accommodate the size of aggregate.

The first charge of concrete shall be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of the concrete and water. The tremie pipe shall always penetrate well into the concrete to prevent accidental withdrawal if the pipe is surged to discharge concrete.

The concrete shall be wholly deposited by tremie and the method of deposition shall not be changed part way up to prevent the laitance from being entrapped within the structure. All tremie pipes shall be cleaned after use.

Bottom dump buckets will not be permitted. Still water shall be maintained at the point of deposit and the forms underwater shall be tight. The tremie tube shall be supported to permit free movement of the discharge end over the entire surface of the work and to permit rapid adjustment to the flow of concrete.

The concrete shall be placed full depth in one continuous operation completing the work to grade progressively. The tremie tube shall be kept in the freshly deposited concrete at all times, being withdrawn only at the completion of a pour. After withdrawing the tremie tube it shall be recharged with concrete above water and lowered to the new position where the discharge end can be placed below freshly deposited concrete.

During placing operations, the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the flow of concrete shall be induced by raising the discharge end of the tube slightly but not out of the concrete. The tremie tube shall be equipped such that the bottom end will be closed when pipe is not enclosed by concrete.

An approved tremie shall consist of a water tight tube fitted with a valve or other approved device to ensure that the surrounding water is prevented from mixing with the concrete during the initial concrete charge. The base of the tube shall sit on the bottom of the pour while the initial charge is affected. The tube and the hopper shall be completely filled with concrete before the base valve is opened.

The tremie shall be capable of controlled movement at the discharge end in both lateral and vertical directions and shall be capable of rapid lowering at any time to decrease the discharge rate of the concrete. The flow of concrete shall be regulated by adjusting the depth so the discharge end is submerged below the surface of the freshly placed concrete.

The placement of concrete shall be through the use of gravity flow tremies only, concrete pumps will not be permitted. The concrete shall not be subjected to any physical disturbance after placement. Adequate allowance shall be made when concreting to provide for the subsequent removal of the contaminated surface layer. If the finished surface of the concrete rises above the water level, the contaminated concrete may be removed before hardening occurs. When dewatering in completed, structural concrete shall have all unsound or contaminated areas removed.

3.5 PLACING FLOOR SLABS ON GRADE. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the Engineer.
The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50°F. long enough to remove all frost from the subgrade.

The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.

Thirty pound felt paper shall be provided between edges of slab on grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.

Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03251 - Joints in Concrete.

Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03345 - Concrete Finishes.

3.6 PLACING CONCRETE UNDER PRESSURE (PUMPING). Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. Concrete may be conveyed using a pump only when authorized by the ENGINEER.

The maximum size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms.

No aluminum parts shall be in contact with the concrete during the entire placing of concrete under pressure at any time.

Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a recognized testing laboratory proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions may be required by the ENGINEER prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used; the same pump and operator shall be present and the pipe and pipe layouts will reflect the maximum height and distances contemplated.
If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.

The minimum diameter of the hose (conduits) shall be 4 inches.

Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.

Concrete samples for quality control in accordance with Article 3.9 and will be taken at the placement (discharge) end of the line.

3.7 ORDER OF PLACING CONCRETE. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in an alternating or checkerboard pattern.

3.8 CONCRETE WORK IN COLD WEATHER. Cold weather concreting procedures shall conform to the requirements of ACI 306.

The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F.

All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature in excess of 100°. in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and ground with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.9 CONCRETE WORK IN HOT WEATHER. Hot weather concreting procedures shall conform to the requirements of ACI 305.

When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand an in position prior to each placing operation.

Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.

The temperature of the concrete mix when placed shall not exceed 90°F.

Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.

Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.

The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

Temperature Limits of Mixture: The temperature of the cement, at the time of delivery to the mixer, shall not exceed 165°F. It may be required that it be stored at CONTRACTOR’s expense until cooled to that temperature.

The temperature limits of aggregates and water entering the mixer shall be as follows:

LIMITS OF TEMPERATURES

	Minimum	Maximum
Water	75°F	140°F
Fine Aggregate	65°F	140°F
Coarse Aggregate	65°F	110°F
Concrete (resulting)	60°F	90°F

3.10 QUALITY CONTROL.

3.10.01 Field Testing of Concrete. The Contractor shall coordinate with the Owner's project representative the on-site scheduling of the testing firm's personnel as required for concrete testing.

Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner. In addition Contractor shall provide assistance to the testing laboratory employed by the Contractor in obtaining samples. The Contractor shall dispose of and clean up all excess material.

Tests shall be made of each batch of concrete delivered, each 50 cubic yards, or whenever consistency appears to vary. The sampling and testing of slump, air content and strength will be performed at no cost to the Owner. Composite samples shall be secured in accordance with the Method of Sampling Fresh Concrete, ASTM C172

3.10.02 Consistency. The consistency of the concrete will be checked by the Engineer by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer may direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications.

Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

Concrete with a specified nominal slump shall be placed having a slump of +/-1 inch of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

3.10.03 Air Content. Samples of freshly mixed concrete will be tested for entrained air content by the Engineer in accordance with ASTM C 231.

Air content tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

In the event that test results are outside the limits specified, additional tests will be run. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

3.10.04 Compressive Strength. Samples of freshly mixed concrete will be taken by the independent test laboratory and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein. Any deviations from the requirements specified shall be recorded in the test report.
In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each fifty (50) cubic yards of concrete, whichever is greater.

Each sampling shall consist of at least four (4) cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The

Engineer will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.

The Contractor shall be required to furnish labor to the independent test laboratory in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.

When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

Compression tests shall be performed in accordance with ASTM C 39. One test cylinder will be tested at seven days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.

The acceptance test results shall be the average of the strengths of the two (2) specimens tested at 28 days. If one (1) specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded.

Acceptance of Concrete: The strength level of the concrete will be considered satisfactory so long as the averages of all sets of three (3) consecutive strength test results equal or exceed the specified 28-day strength and no individual strength test result falls below the specified 28-day strength by more than 500 psi. If the strength test is not acceptable, further testing shall be performed to qualify the concrete.

Concrete Temperature: Determine the temperature of concrete sample for each strength test.

3.10.05 Evaluation and Acceptance of Concrete. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214 and ACI 318.

The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.

The average of 28-day cylinder tests for any three consecutive samplings shall meet or exceed the strength required for the mix specified (see Article 2.6).

No more than 20 percent of the compressive tests have strengths less than that specified.

No individual compressive strength test results falls below the specified strength by more than 500 psi.

In the event that any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.

In the event that condition 2c is not met, additional tests in accordance with Article 3-9, Paragraph F shall be performed.

When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established strength, the Contractor shall:

Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.
Maintain or add temporary structural support as required.

Correct the mix for the next concrete placement operation, if required to remedy the situation.

All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.

3.10.06 Additional Tests. Additional tests on in-place concrete, when and if order by the Engineer, shall also be provided and paid for by the Contractor.

In the event that the 28-day test cylinders fail to meet the strength requirements as outlined in Article 3-9 Paragraph E, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

Three cores shall be taken for each sample in which the strength requirements were not met. Core holes shall be filled with low slump concrete or mortar.

The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by an independent testing laboratory to be selected by the Engineer.

The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so that its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.

The core specimens shall be taken, if possible, so that no reinforcing steel is within the confines of the core.

The diameter of core specimens should be at least 3 times the maximum nominal size of the course aggregate used in the concrete, but must be at least 2-inches in diameter.

The length of specimen, when capped, shall be at least twice the diameter of the specimen.

The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.

Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average of the test results on core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.

In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage an independent test laboratory to be selected by the Engineer, to obtain and test samples for air content in accordance with ASTM Specification C 457.

3.11 CARE AND REPAIR OF CONCRETE. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

Areas of honeycomb shall be chipped back to sound concrete and repaired as directed by the Engineer.

Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed by the Engineer. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed by the Engineer.

Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed by the Engineer.

Concrete which fails to meet the strength requirements as outlined in Article 3-9 Paragraph E, will be analyzed by the Engineer as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be directed by the Engineer.

Testing of Concrete In Place: Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements shall be at the expense of the Contractor.

Nondestructive Devices: Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer to determine relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection.

Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average of the test results on core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength and if the lowest core strength is greater than 75% of the specified 28-day strength.

In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage the independent test laboratory to obtain and test samples for air content in accordance with ASTM Specification C 457.

End of Section

SECTION 03345

CONCRETE CURING AND FINISHING

PART 1 - GENERAL

1.1 SCOPE. This section includes procedures, materials, and techniques required to cure and achieve an exposed finish on horizontal, sloped, or vertical concrete surfaces, including final cleaning.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

ACI 301, “Specifications for Structural Concrete for Buildings.”

ACI 302.1, “Guide for Concrete Floor and Slab Construction.”

ACI 308, “Standard Practice for Curing Concrete.”

ASTM C171, “Sheet Materials for Curing Concrete.”

ASTM C309, “Liquid Membrane-Forming Compounds for Curing Concrete.”

ASTM L881, “Epoxy Resin-Base Bonding Systems for Concrete

ASTM D2103, “Polyethylene Film and Sheeting.”

ASTM E1155, “Method for Determining FF (Floor Flatness and Levelness Using the F-Number System).”

ASTM C150, “Portland Cement.”

1.3 QUALITY ASSURANCE. Perform work in accordance ACI 301 and ACI 302.

Comply with air pollution regulations of governing authorities.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit data on curing compounds, curing papers, and slip resistant treatments including compatibilities and limitations.

1.4.02 Samples. Submit samples not less than 12 inch (30.48 cm) by 12 inch (30.48 cm) size of each type of processed concrete finish, indicating materials and methods used to produce finishes. Engineer's review will be for color and texture only.

Prepare sample finishes on mock-up panels erected under Master Specification Section 03300, Cast-in-Place Concrete.

Submit two 5 lb (2.268 kg) plastic bags of each aggregate specified, illustrating size, color and the extremes of color range.

1.4.03 Mock-Up. Apply surface finishes to sample concrete units or project control mock-up panels in presence of Engineer. Provide workmanship and procedures as required to match approved finish samples.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver curing and finishing materials in manufacturer's packaging including application instructions. Store materials in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pre-cure Finishing Aid. BASF MasterKure ER 50, Euclid "Eucbar", L&M Chemical "E-Con", Master Builders "Confilm", or Sika "Sikafilm".

2.1.02 Polyethylene Film. Product Standard PS17, 6 mils or thicker.

2.1.03 Nonslip Aggregate. Fused aluminum oxide grits or crushed emery abrasive aggregates for nonslip finish, certified by manufacturer to be rustproof, nonglazing, and unaffected by freezing, moisture, and cleaning materials; factory-graded and packaged. Aluminum oxide aggregate; L & M Chemical "Grip It" or BASF "Frictex H".

2.1.04 Absorptive Cover. Burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard (305 grams per square meter), complying with AASHTO M 182, Class 2.

2.1.05 Moisture-Retaining Cover. Shall comply with ASTM C171. Curing paper, polyethylene film and white burlap-polyethylene sheeting are all acceptable products.

2.1.06 Chemical Hardener. Colorless, aqueous solution of fluosilicates and wetting agents for application to cured concrete for surface densification.

2.1.07 Membrane Curing Compound – Dissipating Type. ASTM C309, Type 1, Class A & B. Use non-yellowing formulation where subject to ultraviolet light. Cured film must start to chemically break down in four to six weeks after application; unit moisture loss 0.113 PSF (0.55 kg/m^2) maximum; Conspec “RX Cure WB”.

2.1.08 Membrane Curing Compound and Floor Sealer. Shall be Fed Spec TT-C-800, Type I, Class 1, minimum 18 percent solids, non-yellowing, unit moisture loss 0.08 PSF (0.390 kg/m^2) maximum; L&M Chemical “Dress & Seal”, BASF “Kure-N-Seal”, Dayton Superior “Cure & Seal”, or “ Euclid “Super Diamond Clear”.

As on alternative, comply with ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, nonyellowing, unit moisture loss 0.082 PSF (0.40 kg/m^2) maximum in 72 hours; L&M Chemical “Dress & Seal 30”, Master Builders “Masterkure-N-Seal HS”, BASF “Kure-N-Seal 25 LV”, or Dayton Superior “Cure & Seal 30”.

When using curing and sealing compound and where indicated, provide curing and sealing formulation with long-lasting finish that is resistant to chemicals, oil, grease, deicing salts, and abrasion.

2.1.09 Bonding Compound. Non-redispersable acrylic bonding admixture, ASTM C1059, Type II.

2.1.10 Epoxy Bonding System. ASTM C881; type, grade, and class as required for project conditions.

PART 3 - EXECUTION

3.3 INSTALLATION.

3.1.01 Curing. Protect freshly placed concrete from prematurely drying and excessively cold or hot temperatures. Start curing as soon as free water has disappeared from the concrete surface after placement and finishing. Maintain curing for at least 7 days (10 days for high-early-strength concrete) after placement.

Curing of concrete shall be done by water curing, by membrane curing, by curing compound, or by combination thereof or by other method approved by the Engineer.

Curing of concrete shall be done by methods that will keep the concrete surfaces adequately wet for the specified curing period. Avoid rapid drying at the end of the curing period by slowly reducing the wetting of concrete surface for the next 3 days, after the 7-day (10-day for high-early-strength) specified curing period.

3.1.02 Water Curing. Water saturation of concrete surfaces shall begin as soon as possible after initial set. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. Acceptable methods of water curing are described in ACI 308. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

3.1.03 Membrane Curing. Unless otherwise specified, membrane curing compound may be used instead of water curing on concrete which will not be covered later with topping, mortar, or additional concrete.

Membrane Curing compound shall be sprayed at a coverage rate of no more than 300 square feet per gallon (7.36 square meters per liter). The spray equipment shall have sufficient capacity to continuously spray curing compound at approximately 40 psi (2.81 kg/cm^2) with a suitable nozzle as recommended by the manufacturer. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces.

Where compounds are proposed for use on surfaces to which finishes, coatings, or coverings subsequently will be applied, compound shall possess demonstrated compatibility with finish, coating, or covering.

3.1.04 Curing Compound. Apply at rate stated by manufacturer to conform with moisture-retention requirements specified, using second, immediate application at right angles to first, if necessary, and reapply if damaged by rain.

Use curing compounds only in locations permitted or required, and where use will not interfere with other finish, coatings, or coverings to be applied.

3.1.05 Curing and Sealing Compound. Where indicated, provide curing and sealing formulation with long-lasting finish that is resistant to chemicals, oil, grease, deicing salts, and abrasion.

Apply at rate stated by manufacturer to conform with moisture-retention requirements specified, using second, immediate application at right angles to first, if necessary, and reapply if damaged by rain. Apply additional coat near substantial completion to act as sealer.

3.1.06 Curing and Hardening Compound. Apply one or more applications as recommended by manufacturer to achieve maximum hardness and at rate stated by manufacturer to conform with moisture-retention requirements specified.

Use curing compound only in locations permitted or required. Do not apply to surfaces to receive other finishes, coatings, or covers.

3.1.07 Film Curing. Unless otherwise specified, film curing with polyethylene sheeting may be used instead of water curing on concrete to be covered later with mortar or additional concrete, or which will otherwise not be exposed to view.

Film curing shall begin as soon as possible after initial set of the concrete. The concrete surfaces shall be completely covered with polyethylene sheeting. Sheeting shall overlap the edges of the concrete for proper sealing and anchorage, and joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and as necessary to prevent billowing on the surface.

3.1.08 Surface Not in Contact with Forms. Start curing as soon as free water has disappeared, but before surface is dry. Place to protect adjacent concrete edges. Acceptable curing methods include:

Water ponding

Water-saturated sand

Water-fog spray

Saturated burlap. Provide 4 inch (10.16 cm) minimum overlap at joints

3.1.09 Moisture Retaining Cover. Lap not less than 3 inches (7.62 cm) at edges and ends, and seal with waterproof tape or adhesive. Repair holes or tears during curing period with same tape or adhesive. Maintain covering in intimate contact with concrete surface. Extend covering past slab edges at least twice the thickness of slab. Secure to avoid displacement. Do not use plastic sheeting on surfaces which will be exposed to view when in service.

3.1.10 Finishing. Remove and replace defective concrete, which is not properly formed, is out of alignment or level, or displays surface defects, unless Engineer permits patching or other corrective measures. Permission to patch defective concrete is not a waiver of Engineer’s right to require complete removal of defective work if patching does not, in his opinion, satisfactorily restore quality and appearance of surface.

Perform patching, when permitted, in compliance with applicable provisions of “Concrete Work”.

Do not directly apply water to slab surface or dust with cement.

Use hand or powered equipment only as recommended in ACI 302.1 R.

3.1.11 Floating. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color, and unless additional finishing is specifically required, shall produce the completed finish for unformed surfaces. Floating shall be done with hand floats or suitable mechanical compactor-floats.

3.1.12 Screeding. Strikeoff to required grade and within surface tolerances indicated. Verify conformance to surface tolerances. Correct deficiencies while concrete is still plastic.

3.1.13 Bull Floating. Immediately following screening bull float or darby float before bleed water appears to eliminate ridges, fill in voids, and embed coarse aggregate. Recheck and correct surface to within tolerances.

Do not perform subsequent finishing until excess moisture or bleed water has disappeared and concrete will support either foot pressure with less than 1/4 inch (6.4 mm) indentation or weight of power floats without damaging flatness.

3.1.14 Final Floating. Float to embed coarse aggregate, to eliminate ridges, to compact concrete, to consolidate mortar at surface, and to achieve uniform, sandy texture. Recheck and correct surface to within tolerances.

3.1.15 Broom Finish. Exterior concrete surfaces and all exterior concrete stair treads shall be given a light broom finish to produce a nonslip surface. Brooming, approximately 1/16 inch (1.6 mm) deep, shall be done after the second floating and at right angles to the normal direction of traffic.

3.1.16 Nonslip Finish. Tread surfaces of all interior concrete and concrete filled pan type stairs shall be surfaced with nonslip aluminum oxide aggregate. Aggregate shall be uniformly graded from 100 percent retained on a No. 50 sieve to 100 percent passing a No. 8 sieve. Aggregate shall be uniformly distributed during steel troweling at the rate of 1/4 pound per square foot (1.22 kg/m^2), in accordance with the manufacturer’s recommendations and as acceptable to the Engineer.

3.1.17 Troweling. Surfaces to receive troweling shall include interior floor surfaces which will be exposed after construction is completed; surfaces to be covered with resilient floor coverings, thinset terrazzo, or seamless floor covering; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the drawings shall be steel trowel finished. Surfaces to be covered with Elastomeric deck covering shall be lightly troweled but not burnished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

Trowel immediately following final floating. Apply first troweling with power trowel except in confined areas, and apply subsequent trowelings with hand trowels. Wait between trowlings to allow concrete to harden. Do not overtrowel. Begin final troweling when surface produces a ringing sound as trowel is moved over it. Consolidate concrete surface by final troweling operation. Completed surface shall be free of trowel marks, uniform in texture and appearance, and within surface tolerance specified.

Grind smooth surface defects which would telegraph through final floor covering system.

Finishing Surfaces for Bonding: All surfaces to be covered with concrete or topping shall be float finished. All laitance, surface mortar, and unsound material shall be removed by brushing or air blasting at the time of initial set. Surfaces shall be rough, clean, and sound. Floors and other flat surfaces to receive topping shall be given a broom finish.

Edging: Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having a 3/4 inch (1.9 cm) corner radius.

Duct Bank Finishing: After screeding and before final floating, a red concrete surface coloring shall be dusted on the fresh concrete surface at the rate recommended by the manufacturer.

3.1.18 Finishing Formed Surfaces. Fins and other concrete surface projections shall be removed from all formed surfaces, except exterior surfaces that will be in contact with earth backfill and are not specified to be dampproofed. A power grinder shall be used, if necessary. Surfaces to be dampproofed shall have fins removed and tie holes filled, but no additional finishing will be required.

3.1.19 Tie Holes. Tie holes in formed surfaces shall be cleaned, wetted, and filled with patching mortar. The patches shall be finished flush and shall match the texture of the adjacent concrete.

3.1.20 Special Surface Treatment. All exterior concrete surfaces which are exposed to view shall be grout cleaned. Grout-cleaned finish shall conform to Paragraph 5.3.3.4.b of ACI 301. Grout cleaning shall not result in an overall plastering of the concrete surfaces, but shall produce a smooth, uniform surface free of marks, voids, surface glaze, and cement dust.

End of Section

SECTION 03371

SHOTCRETE

PART 1 - GENERAL

1.1 SCOPE. Section includes the requirements for materials, proportioning and application of shotcrete – pneumatically applied concrete.

1.2 GENERAL.

1.2.01 Coordination. Coordinate the work with associated items that are placed within shotcrete work. Coordinate with sculpturing rough-in work, coloring/staining requirements, and associated or adjacent materials.

Convene pre-installation meeting minimum one week prior to commencing work of this section.

1.2.02 Governing Standards.

ACI 506.2, "Specification for Materials, Proportioning, and Application of Shotcrete."

ACI 301, "Specification for Structural Concrete for Buildings."

ASTM A185, "Steel Welded Wire Fabric, Plain, for Concrete Reinforcement."

ASTM A497, "Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement."

ASTM C33, "Concrete Aggregates."

ASTM C150, "Portland Cement."

ASTM C260, "Air Entraining Admixtures for Concrete."

ASTM C330, "Lightweight Aggregates for Structural Concrete."

ASTM C494/C494M, "Chemical Admixtures for Concrete."

1.3 QUALITY ASSURANCE. Perform work in accordance with ACI 506.2. Perform work of this section under direct supervision of a professional engineer experienced in design of this work and licensed in the State of Michigan.

1.3.01 Contractors Qualifications. Company specializing in performing the work of this section with minimum five (5) years documented experience.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate formwork, dimensions and thickness, tolerances, and accessories. Submit data on admixtures, mix design and test reports.

1.4.02 Samples. Prepare specimens for examination and testing prior to construction.

1.4.03 Mock-Up. Construct two sample panels, 3 feet (91.44 cm) long by 3 feet wide, to indicate range of special treatment or finish required.

Prior to starting work, also provide mock-ups for evaluation of materials and workmanship. Provide three test panels fabricated by placing shotcrete onto plywood for each mix design being considered, for each shooting position to be encountered. Form panels to same shotcrete thickness as the structure, but not less than 3 inches (7.62 cm).

Repair core holes after testing, in accordance with ACI 506.2. Mock-ups may remain as part of the work.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Maintain material and surrounding air temperature at minimum 50 degrees F (10 degrees C) prior to and during installation, and maintain material at this minimum temperature for 7 days after completion of work. Provide equipment and cover to maintain minimum temperature.

Suspend shotcrete operations during high winds, rainy weather, or near freezing temperatures when work cannot be protected.

2.2 ACCEPTABLE APPLICATORS. Acceptable companies include D.C. Byers Co., Detroit; Mid-American Gunite, Newport, and others as approved.

2.3 MATERIALS.

2.3.01 Cement. Shall be ASTM C150, Type I or Type II.

2.3.02 Aggregate. Shall be normal weight, ASTM C33 3/8 inch (9.5 mm) maximum size.

2.3.03 Admixtures. Shall be chemical types conforming to ASTM C494. Air entraining type conforming to ASTM C260. These admixtures are only used in "wet mix" applications.

2.3.04 Reinforcing Bars. Shall be type and size as specified in Master Specification Section 03200, Concrete Reinforcement.

2.3.05 Reinforcing Mesh. Shall be welded wire fabric, ASTM A185 or ASTM A497, galvanized, epoxy coated.

2.3.06 Water. Shall be clean, potable, and not detrimental to shotcrete.

2.3.07 Curing Compound. Shall not be detrimental to application of subsequent surface finish materials.

2.3.08 Bonding Agent. Shall be compatible with substrate and subsequent materials.

2.3.09 Alignment Wire. Shall be small gage, high strength steel wire.

2.4 PROPORTIONING.

2.4.01 Shotcrete Mix. Provide wet or dry mix design that gives good compaction and low percentage of rebound, is stiff enough not to sag, maximum aggregate size of 3/8 inch (9.5 mm) and air entertainment of 5 percent and has a minimum:

Compressive Strength ASTM C109	4000 psi (281.23 kg/cm^2) @ 28 days
Direct Tensile Bond, ACI 503R	180 psi (12.66 kg/cm2) @ 28 days
Flexural Strength, ASTM C348	1800 psi (126.56 kg/cm2) @ 28 days
Splitting Tensile Strength, ASTM C496	45.70 psi (12.66 kg/cm2) @ 28 days
Slant Shear Bond Strength, ASTM C882	400 psi (28.12 kg/cm2) @ 28 days

Maintain quality control records during production of shotcrete; make records available.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that conditions are acceptable and are ready to receive work.

Verify field measurements are as shown on Drawings. Verify fabricated forms are true to line and dimension, adequately braced against vibration during placement, constructed to permit escape of air during gunning operations, and constructed to minimize rebound during gunning operations.

Ensure correct placement of reinforcement and sufficient clearance exists around reinforcement to permit complete encasement.

Ensure easy access to shotcrete surfaces for screening and finishing, and to permit uninterrupted application.

3.2 PREPARATION. Remove existing unsound concrete from substrate surfaces.

Minimize abrupt changes in thickness of repair. Remove square external corners from substrate by rounding the edges.

Clean surfaces to receive shotcrete. Clean and wet cementitious or absorptive substrate surfaces prior to receiving shotcrete. Keep porous surfaces damp for several hours prior to placement of shotcrete. Apply bonding agent, if required.

Determine operating procedures for placement in close quarters, extended distances, or around unusual obstructions where placement velocities and mix consistency may be adjusted during application.

Protect adjacent surfaces not receiving shotcrete.

3.2.01 Alignment Control. Provide alignment wire to establish thickness and plane of required surfaces. Install alignment wire at corners and offsets not established by forms. Tighten alignment wire true to line. Position adjustment devices to permit additional tightening.

3.3 INSTALLATION. Place reinforcement in accordance with ACI 506.2.

Use mixing and delivery equipment capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous and uniform placement.

Do not apply shotcrete more than 45 minutes after adding Portland cement to the mix.

Do not place shotcrete on surfaces that are frozen, spongy, or where there is free water.

Achieve maximum compaction with minimum rebound.

Build-up to required thickness in multiple passes to achieve layering. Encase reinforcement with the first pass.

Allow each layer to take initial set before applying succeeding layers.

Do not permit applied shotcrete to sag, slough, or displace.

After initial set of final layer, remove excess material outside of forms and alignment lines.

Sandblast to remove laitance. Clean with air/water pressure.

Finish surface of final layer with steel trowel and brush, finish to match existing.

Remove rebound material, which does not fall clear of work. Discard salvaged rebound.

Maintain shotcrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of shotcrete.

Immediately after placement, protect shotcrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

Maintain surfaces wet for a minimum of 7 days.

Sound test the applied material with hammer for voids. Expose voids and replace with new shotcrete ensuring full bond with adjacent work.

3.3.01 Protection Of Installed Work. Do not permit applied work to damage adjacent surfaces.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. Provide inspection and testing for conformance to design mix. Test samples in accordance with ACI 506.2. To test mock-up panels, drill 3 inch diameter core samples from test panels. Test for strength, water absorption, drying and shrinkage.

Modify mix design as required based on results of testing.

Provide additional test panels, as specified for mock-up, during the course of the work as may be requested by the Engineer.

End of Section

SECTION 03410

PLANT- PRECAST STRUCTURAL CONCRETE

PART 1 – GENERAL

1.1 SCOPE. This section includes plant precast and prestressed concrete members, used as building structural framing members, of standard or custom size; with lifting, supporting, and connection devices; standard or stressing reinforcement, and minor surface finish options.

Section includes columns and bearing saddles; beams, spandrels, girders, purlins; floor, grout packing; connection devices; and lintels.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards.

ACI 301, "Specification for Structural Concrete for Buildings.

ACI 318, "Building Code Requirements for Structural Concrete and Commentary."

ASCE 7-93 (American Society of Civil Engineers), "Minimum Design Loads for Buildings and Other Structures."

ASTM A36 (American Society for Testing and Materials), "Specification for Carbon Structural Steel."

ASTM A82, "Specification for Steel Wire, Pain, for Concrete Reinforcement."

ASTM A123/A123M, "Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and steel Products."

ASTM A153/A153M, "Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware."

ASTM A185, "Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement."

ASTM A416/A416M, "Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete."

ASTM A497, "Steel Welded Wire Fabric, Deformed, for Concrete

Reinforcement."

ASTM A615/A615M, "Deformed and Plain Billet-Steel Bars for Concrete Reinforcement."

ASTM A666, "Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar."

ASTM C33, "Concrete Aggregates."

ASTM C39/C39M, "Test Method for Compressive Strength of Cylindrical Concrete Specimens."

ASTM C88, "Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate."

ASTM C150, "Portland Cement."

ASTM C260, "Air-Entraining Admixtures for Concrete."

ASTM C494/C494M, "Chemical Admixtures for Concrete."

ASTM C979, "Pigments for Integrally Colored Concrete."

ASTM E329, "Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction."

ASTM F593, "Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs."

AWS D1.1 (American Welding Society), "Structural Welding Code – Steel."

AWS D1.4, "Structural Welding Code – Reinforcing Steel."

Michigan Building Code – Latest Edition

Military Specification DOD-P-21035A, "Paint, High Zinc Dust Content, Galvanizing Repair."

PCI MNL-117 (Precast/Prestressses Concrete Institute), "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

PCI MNL-116, "Manual for Quality Control for Plants and Production of

Precast and Prestressed Concrete Products."

PCI MNL-120, "Design Handbook - Precast and Prestressed Concrete."

PCI MNL-123, "Manual on Design of Connections for Precast Prestressed Concrete."

PCI MNL-124, "PCI Design for Fire Resistance of Precast Prestressed Concrete."

PCI MNL-126, "Manual for the Design of Hollowcore Slabs."

UL (Underwriters Laboratory, Inc.), "Fire Resistive Directory"

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit shop drawings prepared by or under the supervision of a Professional Engineer registered in the State of Michigan experienced in precast work. Do not commence preparation of shop drawings until the structural analysis and design are reviewed by the Contractor.

Shop drawings shall include at least the following:

Unit shapes (elevations and sections), and dimensions.

Finishes.

Reinforcement, joint, and connection details.

Lifting and erection inserts.

Location, dimensional tolerances, and details of anchorage devices that are embedded in or attached to structure or other construction. Furnish template if required for accuracy.

Other items cast into panels.

Handling procedures, plans and/or elevations showing panel location, and sequence of erection for special conditions.

Relationship to adjacent material. Show location of unit by same identification mark placed on panel.

Indicate welded connections by means of standard AWS symbols.

Panel openings intended to be field-cut.

Submit complete design calculations including connections for each type of precast unit. Employ a Professional Engineer experienced in precast/prestressed design and licensed in the State of Michigan to perform calculations. If computerized calculations are performed, submit a sample problem with all manual calculations and the details of the program.

Submit design modifications necessary to meet performance requirements and field coordination. Do not allow variations in details or materials to adversely affect the appearance, durability or strength of units. Maintain general design concept without altering size of members, profiles and alignment. Submit, on request, materials reports, compressive strength tests on concrete and water absorption tests on units.

1.3.02 Samples. Submit samples representative of precast structural concrete panel finished exposed surfaces showing complete range of color, texture, and profiles at panel edges of finished work. The sample's representative size and type is to be determined by Engineer.

1.4 QUALITY ASSURANCE.

1.4.01 Welding Qualifications. Employ welders qualified under AWS D1.1.

1.4.02 Contractor's Qualifications. Employ a fabricator who has a minimum of 5 years previous experience in the fabrication of precast structural concrete. Submit evidence of such experience, including a list of projects for which the work was similar in scope and quality to that specified.

Employ a fabricator who has the production capacity to fabricate the required units without causing delay in the Work and is a "PCI Certified" plant and a participating member of the PCI quality assurance program.

Employ an erector who has a minimum of 5 years previous experience in erection of structural precast concrete units similar to those required on this Project.

1.4.03 Testing. Testing shall be in general compliance with testing provision in PCI MNL-117. Testing agency shall have not less than 2 years experience in performing concrete tests of type specified in this section and capable of performing testing in accordance with ASTM E329.

After samples are accepted for finish, and prior to production, fabricate a full size unit finished to match the approved samples. Do not proceed with product of units until the full size unit has been approved. Approved mockup construction shall represent the standard of workmanship, shall be shipped to the Project site, and may be installed in the work.

1.5 DELIVERY, STORAGE AND HANDLING.

1.5.01 Delivery and Handling. Deliver structural precast concrete units to Project site in such quantities and at such times to assure continuity of erection.

Handle and transport units in a position consistent with their shape and design in order to avoid stress which would cause cracking or damage. Do not place units directly on ground.

Lift or support units only at the points shown on the shop drawings. Lifting or handling devices shall be capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.

Place non-staining resilient spacers of even thickness between each unit. Support units during shipment on non-staining shock-absorbing material.

1.5.02 Storage at Jobsite. Store and protect units to prevent contact with soil, staining, and physical damage.

Store units, unless otherwise specified, with non-staining, resilient supports located in same positions as when transported.

Store units on firm, level, and smooth surfaces to prevent cracking, distortion, warping or other physical damage.

Place stored units so that identification marks are discernible, and so that product can be inspected.

Mark each member with date of production and final position in structure.

1.6 WARRANTY. Warrant the work for 5 years against defects in materials and workmanship resulting in warping, spalling or disintegration, and against other defects affecting the strength, durability or appearance of the work.

During this period, restore defective work to the standard of the Contract documents, including all materials, labor, refinishing and other costs incidental to the work. Inspect the work within 24 hours after receipt of notice from the Engineer and immediately repair leaks in the work. Restore work found to be defective, as designed in the Contract documents, within 10 days after receipt of notice from the Engineer.

1.7 COORDINATION. Coordinate field cut openings in precast concrete deck with affected section. Field cut openings shall be no larger than 12 inches square or 12 inches diameter. Location to be approved by Engineer and Fabricator. Coordinate and confirm factory-cut openings larger than 12 inches square of 12 inches in diameter. Provide headers as required to accommodate openings.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Take field measurements to verify or supplement dimensions indicated.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Engineer, fabricate and install precast structural units to withstand design loads as indicated and as required by the latest local code. Comply with ACI 318 for structural analysis and design.

2.2.01 Design loads. Applicable Building Code: Michigan Building Code. See Drawings for loading information. Dead loads: Include the weight of all indicated permanent construction. Design of precast concrete deck shall include a collateral dead load of 10 psf. Snow drift loading in accordance with Section 1608 of Michigan Building Code shall be considered. Maximum allowable deflection of roof deck shall comply with ACI 318 Table 9.5(b).

Design members exposed to the weather to provide for movement of components without damage, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to seasonal or cyclic day/night temperature ranges.

Design system to accommodate construction tolerances, deflection of other building structural members and clearances of intended openings.

Calculate structural properties of framing member in accordance with ACI 301 ANSI/ACI 318.

Maintain indicated dimensions. Deviations will only be permitted after it is proven by structural analysis that larger or different dimensions are required. Changes in dimension and subject to approval.

2.3 MATERIALS.

2.3.01 Forms. Shall be metal, plastic or wood to produce required finish.

2.3.02 Cement. Shall be ASTM C150, Type I or III, for Portland cement

2.3.03 Coloring Agent. Shall meet ASTM C979. A synthetic mineral oxide that is harmless to concrete setting and strength, stable at high temperature, and is not affected by sunlight.

2.3.04 Aggregates. Shall meet ASTM C33. Coarse aggregate shall be class designation 5S, except as follows. Limit for chart shall be 1.0 percent. Maximum weight loss when subjected to 5 cycles of the ASTM C88 magnesium test shall be 9 percent. Supply coarse aggregates from a single (source) for entire Project. Provide aggregate which is clean, hard, strong, durable, and inert, free of staining or deleterious material.

2.3.05 Water. Shall be potable.

2.3.06 Admixtures: Air-entraining agent shall comply with ASTM C260. High range water reducing (superplasticizer), and retarding admixtures shall comply with ASTM C494.

2.3.07 Reinforcement. Bar reinforcement shall comply with ASTM A615, grade 60. Wire reinforcement shall comply with ASTM A82. Welded wire fabric shall comply with ASTM A185 or ASTM A497. Reinforcement and accessories within 1 1/2 inches (3.81 cm) or exterior exposed surfaces shall be galvanized or epoxy coat.

2.3.08 Prestressing Strands. Prestressing strands shall be uncoated 7 wire, stress-relieved, high-strength strands grade 250 or 270K. Comply with ASTM A416/A416M-12a "Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete".

2.3.09 Shear Ties: Shall be No. 16 – 18 gage galvanized metal, 3/4 inch (1.9 cm) wide, flattened and shaped into a channel section, or galvanized commercial truss member with top and bottom chord of double 7 gage wires and web members of single 7 gage wire.

Provide support for reinforcement, including bolsters, chairs, spacers, and fastening devices. For exposed to view concrete surfaces, where legs of supports are in contact with forms, provide legs that are protected by plastic or stainless steel.

2.3.10 Anchorage Devices. Inserts in the unit for anchorage to the structure shall be 3/4 inch Richmond Screw Anchor Co., Inc., "Rocket", malleable iron threaded insert with machine bolt. Steel for clips, angles and plates shall comply with ASTM A36. Steel exposed to the exterior shall be hot-dip galvanized in accordance with ASTM A153 or ASTM A666 stainless steel.

2.3.11 Welded Anchor Studs: Shall comply with AWS D1.1, Section 4 for anchorage devices, including inserts, bolts, nuts, washers, shims, clips, angles and plates, except devices for welded connections: galvanized or cadmium plated.

Slotted inserts in the unit for attachment of wood nailer at parapet, Unistrut Corp. "Type P-3000 with spring loaded nuts" for 1/4 inch (6.4 mm) bolts, with galvanized finish and standard duty concrete inserts.

Inserts embedded in the units for handling and erection shall be galvanized or cadmium-plated and not protruding from the units.

Reglet embedded in units to receive flashing shall be Fry Reglet Corp. “Original Reglet”, or as approved, PVC complete with spacer channel and vinyl rope backup for sealant.

2.3.12 Rigid Insulation. Shall be Dow Chemical Co., “Styrofoam”.

2.3.13 Coatings. Items specified to be galvanized shall be zinc-coated in accordance with ASTM A153 or A123. Refer to Master Specification Section 09900, Painting for painting ferrous metal.

2.3.14 Grout. Shall be high strength, non-shrink grout.

2.3.15 Bolts, Nuts and Washers. Shall be of high strength steel type recommended for structural steel joints.

2.3.16 Prime Paint. Zinc-rich paint shall be ZRC Chemical Products Co., “Z.R.C.” or other acceptable product complying with DOD-P-21035A.

2.3.17 Form Release Agent. Shall be compatible with the sealant for weatherproofing joints and certified as such by the sealant manufacturer.

2.3.18 Bearing Pads. Shall be random, fiber-reinforced elastomeric pad with pre-formed, randomly oriented synthetic fibers set in elastomer. Surface hardness of 70 to 90 Shore A durometer. Neoprene shall have 50 durometer hardness.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Fabricator. Provide precast structural concrete fabricate in general conformance with PCI MNL-117 by Pre-Con Corp., Kalamazoo, Michigan; Concrete Technology, Inc., Springboro, Ohio; Precast Specialties, Ft. Wayne, Indiana; Bluegrass Artcast, Inc., Lexington, Kentucky; or National Precast, Inc., Roseville, Michigan; Hollowcore Midwest LLC, Ohio, Coreslab Structures, Inc., Sidley Precast Company, Inc, or as approved.

2.4.02 Procedures. Fabricate units to match approved mockup construction before shipment to project site. Manufacturing procedures shall comply with PCI MNL 117.

Provide thickness of deck as indicated on Drawings.

Cast precast members in horizontal forms of rigid construction. Carefully set and secure all reinforcement and embedded items prior to placing of concrete. Maintain maximum quality control throughout the casting and finishing process.

Block out insulation for a distance of 3 inches (7.62 cm) around anchorage devices to provide adequate embedment of the devices.

Cut exposed ends of precast concrete deck sections flush.

2.4.03 Reinforcement. Reinforce members as required by the performance requirements. Furnish additional reinforcement as required for the shipment, handling and erection of members. Fabricate the work within the tolerances specified in PCI MNL 117.

2.4.04 Finishes. Cure members under identical conditions to develop required concrete quality and minimize appearance blemishes such as non-uniformity, straining, or surface cracking.

Provide finish for exposed surfaces matching sample on file in the Engineer's office.

Trowel interior exposed surfaces smooth with edges tooled to 3/4 inch (1.9 cm) radius.

Provide 1/2 inch (1.27 cm) chamfer for external corners of exterior surfaces of sill wall panels.

Color exterior and exposed interior concrete. Ensure that exposed to view finish surfaces of precast concrete are uniform in color and appearance.

See Master Specification Section 09900, Painting for exterior applied finishes if applicable.

Plant finish precast concrete deck sections to PCI MNL-116. Formed surfaces shall have a Commercial Grade B finish. Unformed surfaces shall have a floated finish.

2.4.05 Cover. Provide at least 3/4 inch (1.9 cm) cover for reinforcing steel. Do not use metal chairs, with or without coating, in the finished face. Provide embedded anchors, inserts, plates, angles and other cast-in items as indicated on Shop Drawings with sufficient anchorage and embedment for design requirements

2.4.06 Molds. Use rigid molds to maintain units within specified tolerances conforming to the shape, lines and dimensions shown on the approved Shop Drawings. Construct molds to withstand vibration method selected.

2.4.07 Concreting. Convey concrete from the mixer to place of final deposit by methods which will prevent separation, segregation or loss of material.

Consolidate all concrete in the mold by high frequency vibration, either internal or external or a combination of both, to eliminate unintentional cold joints, honeycomb and to minimize entrapped air on vertical surfaces.

2.4.08 Curing. Use a curing method which does not affect adhesion of materials to be applied to concrete, including paint, sealants, coatings and adhesives. Cure precast concrete units until the compressive strength is high enough to ensure that stripping does not have an effect on the performance or appearance of the final product. After the curing period, store the units without further handling or shipment until compressive strength of concrete is verified by tests.

2.4.09 Panel Identification. Mark each precast concrete panel to correspond to identification mark on shop drawings for panel location. Mark each precast concrete panel with date cast.

2.4.10 Acceptance. Structural precast concrete units which do not meet the color and texture range or the dimensional tolerances may be rejected at the option of the Engineer, if they cannot be satisfactorily corrected.

2.5 PROPORTIONING.

2.5.01 Concrete Properties. Proportioning of concrete (mix design) is the responsibility of the precast concrete manufacturer, complying with ACI 318, Chapter 5. Use HRWR (superplasticizer) in the placement of structural concrete. Provide concrete complying with the following.

Maximum water-cement ratio:	0.40
Minimum compressive strength in 28 days:	5000 psi (351.54 kg/cm^2)
Slump:	3 inches (7.62 cm) before addition of HRWR (superplasticizer)
Air content:	6 percent (plus or minus 1 percent)
Face mix moisture absorption by weight:	6 percent maximum
Total water-soluble chloride ion content of mix, including all constituents:	0.15 percent by weight of cement

Do not place concrete until conformity of all material and concrete mixtures with tests and specifications, including 28 day compressive strength, has been established and approved.

2.5.02 Facing Mix. Minimum thickness of face mix after consolidation shall be at least 1 inch (2.54 cm) or a minimum of 1 1/2 times the maximum size of aggregate used; whichever is larger.

Provide water-cement and cement-aggregate ratios of face and backup mix which are similar.

The design mixes shall be prepared by an independent testing facility or qualified personnel at precast concrete manufacturer's plant.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Erect units straight, plumb and in alignment, and securely anchored to the structural framing, without exceeding the erection and location tolerance of PCI MNL-117.

Provide temporary supports and bracing as required to maintain position, stability and alignment as units are being permanently connected.

Set non-loadbearing units dry without mortar, attaining specified joint dimension with lead, steel, plastic or asbestos cement spacing shims. After units are secured in place, remove spacing shims.

Fasten precast concrete units in place by bolting or welding, or both, completing drypacked joints, grouting sleeves and pockets, and/or placing cast-in-place concrete joints as indicated on approved erection drawings.

Temporary lifting and handling devices cast into the precast concrete units shall be completely removed or, if protectively treated, removed only where they interfere with the work of any other trade.

Grout anchors and dowels with 1-to-3 cement-and-sand grout. Fill erection and unused anchor holes with grout, flush with adjacent surface.

Coat welded connections with prime paint.

Touch-up damaged zinc coating in the field with zinc-rich paint applied in accordance with manufacturer's instructions.

Precast concrete deck: Install bearing pads at bearing ends of planks as indicated. Install headers at openings as required. Adjust differential camber between precast members to tolerance before final attachment and grouting. Adjust differential elevation between precast members to tolerance before final attachment. Grout plank joints and trowel smooth. Transition differential elevation of adjoining planks with grout to a maximum slope of 1:12 to provide a smooth surface. Secure units in place. Welding to comply with AWS D1.1 or D1.4, as applicable. Seal all joints on exposed surfaces.

3.1.02 Joints. Maintain joints at a uniform width as indicated on the Drawings. Maintain surfaces of joints to be weatherproofed clean and approved by the sealant manufacturer.

3.1.03 Damaged Units. Do not install units having broken corners or edges, spalls, cracks or other defects in the work. Remove units erected and later found to be broken, spalled, cracked or otherwise damaged, and replace with approved units matching the adjacent work, unless patching of minor defects is approved in writing.

3.1.04 Cleaning. After installation and joint treatment, clean soiled precast concrete surfaces. Starting at the top of the structure with detergent and water, use fiber brush and sponge, and rinse thoroughly with clean water in accordance with precast concrete manufacturer’s recommendation. Use cleaning materials or processes which will not change the character of exposed concrete finishes. Rinse thoroughly with clean water immediately after using cleaner.

Use extreme care to prevent damage to precast concrete surfaces and adjacent materials.

3.2 FIELD QUALITY CONTROL. Perform quality control and inspection procedures to comply with applicable sections of PCI MNL-117. Conduct water absorption test on units in accordance with PCI MNL-117.

3.2.01 Field Testing. Conduct strength tests and determine slump and air content as specified in Master Specification Section 03300, Cast-in-Place Concrete and also in accordance with ASTM C143. Keep quality control records available for the Engineer upon request for two years after final acceptance.

Test specimens in accordance with ASTM C39. Two specimens will be tested to determine the stripping strength and two specimens will be tested at 28 days for acceptance for each strength test.

Make at least one strength test for each 40 cubic yard (30.58 m^3) or fraction thereof, of each mix design of concrete placed in any one day in accordance with ASTM C31.

Conduct a minimum of three absorption tests for each mix design as per PCI MNL-117, Appendix D, Section 2.1.2(9).

End of Section

SECTION 03600

GROUT

PART 1 - GENERAL

1.1 SCOPE. This section covers grouting of pump, motor, and equipment baseplates or bedplates; column baseplates and miscellaneous baseplates; and other uses of grout as indicated on the drawings. Unless otherwise specified, all grouting shall be done with non-shrinking grout.

This section also covers epoxy grouting of anchor bolts, threaded rod anchors, and reinforcing bars to be installed in hardened concrete. Anchor bolts, adhesive anchors, and threaded rod anchors are covered in the anchor bolts and expansion anchors section.

Grout for masonry is covered in Master Specification Section 04065, Masonry Mortar and Grout.

1.2 GENERAL.

1.2.01 Governing Standards

ASTM C882, “Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.”

ASTM D638, “Test Method for Tensile Properties of Plastics.”

ASTM D695, “Compressive Properties of Rigid Plastics.”

ASTM D790, “Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.”

1.3 QUALITY ASSURANCE. Perform Work per ACI 301 and ACI 304R.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit product data describing the grout, including recommended mixing and placing instructions.

1.4.02 Certifications. Provide copies of material certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

1.5 DELIVERY, STORAGE AND HANDLING. It should be stored under cover and on pallets. In cold weather, store in a warm place for a least 24 hours; 70 degrees F (21 degrees C) is preferred. In hot weather, store in a relatively cool shaded area.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Nonshrinking Grout. Use for grouting equipment base plates, column base plates, pumps, compressors, miscellaneous structural equipment supports, skid mounted equipment, vertical and horizontal vessels, exchangers, blowers, etc.

Non-shrink cement-based grout shall be Grade A (Prehardening Volume Controlled), Grade B (Post Hardening Volume Controlled) or Grade C (Combination Volume Controlled). Must meet all performance criteria of most current version of ASTM C 1107 at a flowable, plastic, and stiff consistency. Compressive strengths at flowable consistency must have at least 7000 psi (492.16 kg/cm^2) at 28 days. Premium Non-Shrink Grout Manufacturers include: Master Builder Technologies, “Set Grout”, L&M Chemicals Inc., “Crystex”, Five Star Products, “Five Star Grout”, Saureisen Cements, “Grout No. F-100”, Sika, “Sikagrout 328”, or equal.

2.1.02 Precision Fluid Non-Shrink Grout with Extended Working Time. Use when base plates are larger than 36 inches 991.44 cm), clearances are less than 1-1/2 inches (3.81 cm), temperatures are greater than 75 degrees F (23.89 degrees C), extended working time is needed, pumping long distances, or anticipated shear loads will be present.

Fluid non-shrink cement-based grout with extended working time shall be Grade B (Post Hardening Volume Controlled) or Grade C (Combination Volume Controlled). Grout shall conform to the most current version of ASTM C 1107 when tested at a fluid consistency of 20-30 seconds per CRD 611/ASTM C 939 at temperature extremes of 45 and 90 degrees F (7.2 and 32.2 degrees C) with an extended working time of 30 minutes at 45 and 90 degrees F (7.2 and 32.2 degrees C). Grout shall have strength of 7500 psi (527.31 kg/cm^2) at 28 days when mixed at fluid consistency. Fluid Grout with Extended Working Time Manufacturers include: Five Star Products, “Five Star 110”, BASF, “Masterflow 928”, Sika, “Sikagrout 328”, or equal.

2.1.03 Metallic Fluid Grout with Extended Working Time. Use when application temperatures are between 55 and 75 degrees F (12.78 and 23.89 degrees C), base plates are larger than 36 inches (91.44 cm) clearance between foundation and plate is less than 1-1/2 inches (3.81 cm), under dynamic load applications, or where shear loads will be anticipated.

Fluid non-shrink metallic grout with extend working time shall be Grade B (Post Hardening Volume Controlled). Grout shall conform to the most current version of ASTM C 1107 wen tested at a fluid consistency of 20 30 seconds per CRD 611/ASTM C 939 at recommended temperatures. Grout shall have strength of 7500 psi (527.31 kg/cm^2) at 28 days when mixed at fluid consistency. Fluid Metallic Grout with Extended Work Time Manufacturers include BASF, “Embeco 885 Grout”, or equal.

2.1.04 Epoxy Grout for Reinforcing Bars and Threaded Rod Anchors. Adhesive For Floors and Horizontal Surfaces for low viscosity shall be moisture-insensitive; BASF Concresive LVI or Sika "Sikadur 35, Hi-Mod LV". For medium viscosity use moisture-insensitive; BASF "Concresive Liquid LPL" or Sika "Sikadur 32, Hi-Mod" or equal..

Adhesive for vertical surfaces and overhead applications shall be Nonsag consistency Moisture-insensitive; Hilti HIT-HY 200, or engineered approved alternate.

2.1.05 Epoxy Grout for Headed Anchor Bolts. Adhesive shall be moisture-insensitive; BASF Masterflow 648 CP+.

Aggregate shall be as recommended by the epoxy grout manufacturer. Aggregate must be completely dry.

2.1.06 Water. Shall be potable quality.

2.1.07 Reinforcing Bars. Shall be ASTM A615, Grade 60, deformed.

PART 3 - EXECUTION

3.1 PREPARATION.

3.1.01 Nonshrinking Grout. Shall be furnished factory premixed so that only water is added at the jobsite. Grout shall be mixed in a mechanical mixer. (No more water shall be used than is necessary to apply product.

Surface Preparation: Steel and concrete surfaces shall be free of dirt, oil, grease or other contaminants.

All surfaces should be roughened to remove laitance and expose sound concrete. When dynamic, shear or tensile forces are anticipated, concrete surfaces should be chipped with a “chisel point” hammer to a roughness of (plus or minus) 3/8 inch (9.5 mm).

Concrete surfaces should be rough and saturated (ponded) with clean water for 24 hours just prior to grouting.

Bolt holes must be grouted before the major portion of grout is placed. Shade the foundation from summer sunlight 24 hours before and 24 hours after grouting. All free-standing water must be removed from the foundation and bolt holes prior to grouting.

Forms should be liquidtight and nonabsorbent. Seal forms with grout, putty or caulking compound. Side and end forms should be a minimum 1 inch (2.5 cm) horizontally away from the object being grouted to permit expulsion of air and any remaining saturation water as the grout is placed. Provide sufficient bracing to prevent the grout from leaking. Large non-supporting grout areas should be eliminated wherever possible. Forms should extend a minimum of 1 inch (2.5 cm) higher than the bottom of the equipment being grouted.

Temperatures for the foundation and plates, mixing water and grout should be 45°F (7° C) minimum, 50 to 80° F (10 to 27 ° C) preferred, and 90° F (32° C) maximum.

Mixing shall be performed with potable water only. Place estimated water into a mortar mixer, then slowly add the dry grout. Adjust the water to achieve the desired flow. Recommended flow for Master Builders fluid grouts is 25 to 30 seconds using the CRD-611 Flow Cone method.

Mix grout a minimum of 5 minutes after all material and water is in the mixer. Do not mix more grout than that can be placed within the working time of the grout. Transport by wheelbarrow, buckets or pump to the equipment to be grouted. Minimize the transporting distance as much as possible. Do not retemper grout by adding water and remixing after it stiffens.

3.1.02 Epoxy Grout. Epoxy grout shall consist of a two-component liquid epoxy adhesive of viscosity appropriate to the location and application, and an inert aggregate filler component, if recommended by the adhesive manufacturer. Components shall be packaged separately at the factory and shall be mixed immediately before use. Proportioning and mixing of the components shall be done in accordance with the manufacturer's recommendations.

Epoxy grout should be placed only on properly cured foundations. The concrete surface must be chipped to expose sound aggregate and to ensure that all laitance and weak float is removed. The concrete base shall be clean, dry and free of oil, wax and other contaminants.

If an anchor bolt sleeve is to be filled, be sure all water is removed. If the anchor bolt sleeve is to be left ungrouted, seal the bolt hole with felt, foam rubber or other means.

Cover all shims, anchor bolts and leveling screws with putty or clay to keep the grout from adhering. Use model clay, glazing putty or anything of a putty consistency which will stick but not harden. Shade the foundation from summer sunlight for at least 24 hours before and 48 hours after grouting.

Where indicated on the drawings, anchor bolts, threaded rod anchors, and reinforcing bars shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be as follows:

For Reinforcing Bars and Threaded Rod Anchors	Diameter shall be 1/8 inch (3.2 mm) larger than the outside diameter of the bar or the rod
For Headed Anchor Bolts	Diameter shall be bolt diameter plus 2 inches (5.08 cm)

The embedment depth for epoxy grouted anchor bolts, threaded rod anchors, and reinforcing bars shall be at least 15 bolt, rod, or bar diameters, unless otherwise indicated on the drawings.

Holes shall be prepared for grouting as recommended by the grout manufacturer.

The bonding surfaces of the base or plate to be grouted should be sandblasted to “white metal” and be free of coatings, wax, grease or scale.

Since the grout will come up at least 1/2 inch (1.27 cm) to 3/4 inch (1.9 cm) onto the equipment, protect above this area with masking tape.

To permit easy clean up, wax or cover all surfaces where the grout may splash.

Forms should extend a minimum of 3/4 inch (1.9 cm) higher than the bottom of the equipment being grouted. Large non-supporting grout areas should be eliminated wherever possible. Protect the foundation and equipment from rain or moisture. Areas not to be grouted must be sealed off.

Forms must be liquid tight. They may be sealed with putty or caulking. Seal wood forms to vertical concrete surfaces by applying putty or caulk below top of concrete, then press form into place.

Place forms within a maximum of 6 inches (15.24 cm) and a minimum of 1 inch (2.54 cm) from the edge of each individual base, rail or sole plate being grouted.

Where a deep pour is necessary, 1/2 inch (1.27 cm) rebar on 12 (30.48) to 18 (45.72) inches (cm) centers shall be used to minimize stress cracking. The top tier should be located about 2 inches (5.08 cm) below the equipment base. A bottom tier should be located about 2 inches (5.08 cm) above the foundation surface. Additional tiers, if required, should be spaced equal distances in the grout pour with vertical supports as required.

Contractor shall use clean and dry mortar mixer (3 to 6 cubic foot (0.085 to 0.170 m^3) size), wheelbarrow, and buckets or shovels for transporting the grout. Have plenty of clean rags for wiping hands and tools. Ready a pail of solvent (T-430, Xylol, Lacquer Thinner) for cleaning hands and tools. Use rubber gloves.

During mixing, do not add solvent, water or any other material to the grout. Do not alter the liquid hardener proportions. Pour the hardener into a pail of grout liquid and stir until well mixed (approximately three minutes). Pour the mixed liquid and hardener into the mixer. Add the grout aggregate one bag at a time and mix until completely wet.

3.2 INSTALLATION.

3.2.01 Nonshrinking Grout. Grout should always be placed from only one side of the equipment to prevent entrapment of air or water beneath the equipment.

After placement, trim the surfaces with a trowel and cover the exposed grout with clean wet rags and maintain this moisture for 5 to 6 hours.

The grout should offer stiff resistance to penetration with a pointed mason’s trowel prior to removing the grout forms or cutting back excessive grout.

Cure all exposed grout with an approved membrane curing compound such as Master Builders Masterkure-N-Seal HS immediately after the wet rags are removed to further minimize the potential moisture loss within the grout.

Do not vibrate grout. Steel straps inserted under the plate may be used to aid in movement of the grout.

Unless otherwise (3.81 cm) specified or indicated on the drawings, grout under baseplates shall be 1-1/2 inches (3.81 cm) thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the top of baseplates and bedplates are completely filled, without voids. Forms shall be provided where structural components of baseplates or bedplates will not confine the grout.

In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate, bedplate, member, or piece of equipment.

Nonshrinking grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 7 days and then an acceptable membrane curing compound shall be applied.

3.2.02 Epoxy Grout. When grouting closed areas, start at one end of the form and fill the cavity completely as you advance toward the other end to prevent air entrapment.

Low foundation and ambient temperatures decrease flowability. Strapping will assist movement of grout in low clearance applications. Do not vibrate grout.

Check frequently for leaks. Leaks do not self-seal. If not stopped they will cause voids.

Anchor bolts, threaded rod anchors, and reinforcing bars shall be clean, dry, and free of grease and other foreign matter when installed. The bolts, rods, and bars shall be set and positioned and the epoxy grout shall be placed and finished in accordance with the recommendations of the grout manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with epoxy grout, without voids.

During assembly of all threaded stainless steel components, anti-seize thread lubricant shall be liberally applied to the threaded portion not embedded in concrete.

End of Section

SECTION 03650

CEMENT STABILIZED FLY ASH

PART 1 - GENERAL

1.1 SCOPE. This section covers labor, equipment, materials and operations necessary to complete fly ash backfilling operations as indicated on the drawings and as specified herein.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C138, “Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.”

ASTM C143/C143M, “Slump of Hydraulic Cement Concrete.”

ASTM C618, “Coal Fly Ash and Raw or Calcimined Natural Pozzolan for use as a Mineral Admixtures in Concrete.”

ASTM C150, “Portland Cement.”

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Cement. Cement shall conform to ASTM C150, Type I.

2.1.02 Fly Ash. The fly ash shall be Class F and meet the requirements of ASTM C618 with no limits on the loss on ignition, fineness, or detailed requirements of the specification.

The Manufacturer shall certify, in writing that the material supplied is non-contaminated in accordance with the current Environmental Protection Agency (EPA) requirements.

2.1.03 Water. Use potable water.

2.1.04 Measuring and Mixing. The stabilized fly ash mixture shall contain 5 percent (plus or minus ½ percent) of Portland cement based on the dry weight of the fly ash. The temperature of the mix shall not be less than 50 degrees F (10 degrees C), measured at the point of placement.

The slump shall be measured at the point of placement. The mixture used for general backfill in trenches, against structures etc., will normally have a slump of from 7 to 10 inches (17.78 to 25.4 cm).

The mixture used for backfill that is required to stand and not flow laterally, or that which is to be used in water will normally have a slump of from 4 to 6 inches (10.16 to 15.24 cm).

The stabilized fly ash mixture shall have a specified unconfined compressive cube strength of 100 psi minimum at 28 days of age. In the event that the laboratory strength does not reach the required 28 day strength. The backfill material supplier must demonstrate that the required strength has been met. This may be done by the use of penetrometer, CBR laboratory test adapted to the field, or an appropriate plate load test.

PART 3 - EXECUTION

3.1 PREPARATION.

3.1.01 Measuring of Materials. The method used to measure fly ash and cement shall be submitted for acceptance. Cement content shall be based on the dry weight of the fly ash in the mix.

The batched weight of fly ash shall be corrected for its moisture content and measured in such a way that compliments the type of batch plant being utilized, thus assuring that the percentage of cement based on the dry weight of fly ash is being satisfactorily controlled.

Water shall be measured, although its control will be a function of consistency (slump and workability of the mix).

A standard unit weight can be determined by use of a standard bucket using ASTM C138 as a guide with the exception that the material should not be rodded. When weights of material are established, the unit weight bucket along with delivery weights can be used as a basis of payment.

3.1.02 Batching and Mixing. The stabilized fly ash can be mixed by a pug mill, central concrete mixer, ready-mix truck, turbine mixer, or other acceptable equipment or method.

The actual batch weights, mixing time, and mix temperature shall be recorded for each slump test and set of test specimens made.

Foreign material may be acceptable providing it has no deleterious effect on the mixer, placing procedure or mixture properties. Generally, occasional lumps of solid material limited to a maximum of 2 inches (5.08 cm) in diameter can be permitted.

3.2 INSTALLATION.

3.2.01 Placement. The material shall be placed by end or side dumping, chutes, conveyors, or other suitable method.

Lines and grades shall be as shown on the Drawings.

Stabilized fly ash shall be protected from freezing temperatures for the initial 24 hours after placement. Protection may consist of earth cover, straw, or a sacrificial layer of the stabilized fly ash mix. Strength gain from the Portland cement will be slow with temperatures of 50 degrees F (10 degrees C) and lower.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Testing. The moisture content as measured by ASTM D2216 shall be used in the mixing process to provide for the moisture correction required for control of production.

Slump tests shall be in accordance with ASTM C143. These shall be made as required to establish slump for a new application and as a control of continuing usage.

One set of 3 cubes 2 inches (5.08 cm) in size shall be made for each test of the compressive strength of the flowable fly ash backfill material. The mold should be filled by jarring the wet material into the form without rodding. Cubes shall remain in the molds for at least 3 days to develop adequate strength to prevent damage caused by handling and then placed in water for curing. The cubes should be removed from the water 24 hours before testing. During this time they should be covered to prevent drying. The specimens should be maintained at a minimum temperature of 70 degrees F (21 degrees C) at all times.

End of Section

SECTION 03700

CONCRETE RESTORATION

PART 1 – GENERAL

1.1 SCOPE. This includes the work of repairing cracks, spalling and other defects in hardened Portland cement concrete. This includes but is not limited to by epoxy injection process.

1.2 GENERAL. The Contractor shall furnish all materials, tools equipment, appliances, transportation, and labor required to restore cracked, spalled or damaged concrete.

1.2.01 Governing Standards.

ASTM C882, “Bond Strength Of Epoxy Resin Systems Used with Concrete, by Slant Shear.”

ASTM D638, “Test Method for Tensile Properties of Plastics.”

ASTM D695, “Compressive Properties of Rigid Plastics.”

ASTM D790. “Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.”

ASTM D2842-01, “Standard Test Method for Water Absorption of Rigid Cellular Plastics.

1.3 QUALITY ASSURANCE.

1.3.01 Contractors Qualifications. Concrete restoration or repair shall be performed by a certified applicator of the structural concrete bonding process with a minimum 5-years experience in structural concrete bonding.

1.3.02 Applicator Qualifications. Contractor’s workmen engaged in the repair process should have satisfactorily completed a program of instructions in the methods of restoring concrete structures, wooden timbers and beams utilizing the epoxy injection process specified. The curriculum shall include theory on the nature and causes of cracking in concrete, methods for permanently repairing damaged concrete structures, the technical aspects of correct material selection and use, and the operation, maintenance and troubleshooting of equipment.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. The Contractor shall submit product data for the repair material to be used.

1.4.02 Certifications. The Contractor shall submit certification for workmen who will engage in the repair of the concrete structures.

1.4.03 Test Reports. The Contractor shall submit test data for all field quality control testing.

PART 2 – PRODUCTS

2.1 MATERIALS.

Material selected for concrete repair shall be appropriate for the application. Use of a bonding agent should be as required by the product manufacturer's specification. Material selection must be approved by the Engineer.

The Hydraulic Cement shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.

2.1.01 Chemical Grout Materials for Injection. The Contractor shall use a high-solids, hydrophobic, expanding chemical grout to prevent water infiltration, as manufactured by Sika or approved equal, for repair of water tanks, wet wells, chambers, and other similar structures under hydraulic pressure.

2.1.02 Shotcrete. The Contractor may use shotcrete as a concrete repair material in accordance with Master Specifications Section 03371, Shotcrete for applications appropriate to the manufacturer.

2.1.03 Gravity Feed Grout. The Contractor shall use Sika "Sikadur 35 Hi-Mod LV" for gravity feed applications as indicated in the Specifications. Prepare area and install grout as per manufacturer's recommendations.

2.1.04 Metallic Aggregate Epoxy Repair Mortar. The Contractor shall use a metallic aggregate epoxy repair mortar for repair of spalled areas and mortar. The epoxy repair mortar shall be Emaco 588-CI, as manufactured by BASF or approved equal. The repair mortar shall achieve 7,600 psi (534.34 kg/sq cm) compressive strength at 28 days.

Contractor shall follow manufacturer recommendation for replacement of repair mortar. Repair mortar, where required shall be placed to a thickness slightly in excess of the finished surface and shall be steel-trowel-finished, flush with the adjacent surface. Repair mortar shall be BASF EMACO Series for structural repair, EMACO R Surface for Surface Blemishes, or equal.

2.2 Equipment. The equipment used to meter and mix the two injection adhesive components and the mixed adhesive into the crack or aggregate shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric or air powered and shall provide in-line metering and mixing.

The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 160 psi (11.25kg/sq cm) and shall be equipped with a manual pressure control override.

The equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 160 psi (11.25 kg/sq cm).

The injection equipment shall be equipped with sensors on both the component A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

PART 3 – EXECUTION

3.1 PREPARATION.
Surfaces shall be prepared according to product manufacturer's specifications. Conflicts between manufacturer's preparation instructions and these specifications should be resolved by the Engineer.

3.1.01 Spall and Crack Repair. Surfaces adjacent to cracks, chipped out sections and other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign matter detrimental to bond of injection surface seal system. Acids and corrosives shall not be permitted for cleaning.
Entry ports shall be provided along the crack at intervals of not less than the thickness of the concrete at that location. Entry port should intersect the crack approximately half-way through the concrete. Port diameter shall be consistent with manufacturer's recommendations.

Spalled concrete areas shall be chipped to sound concrete and any exposed rebar shall be cleaned. Spalling shall be checked to a minimum of 2 feet (61.0 cm) width at each crack.

Areas chipped to sound concrete shall be formed and the formed portion shall be packed with hydraulic cement to a minimum of 3/4 inches (1.9 cm) thickness.
Route or sawcut cracks identified by the Engineer for repair.
Surface seal material shall be applied to the face of the crack between the entry ports. For cracks completely through the concrete, surface seal shall be applied to both faces.

The surface seal material shall have cured to 50 percent of design strength before proceeding with the injection.

The Contractor shall follow manufactures specifications regarding the need for a backer rod.

3.2 INSTALLATION.

3.2.01 Injection. Injection of material shall begin at a lower entry port or at the lowest port of minimal flow and continue until there is an appearance of material at the next entry port adjacent to the entry port being pumped.

When material travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped, and injection shall be transported to the next adjacent port where material has appeared. Each port shall be sealed before pumping of the next port. Perform material injection continuously until cracks are completely filled. If port-to-port travel of material is not indicated, the work shall immediately be stopped and the Engineer must be notified.

Areas to be patched where spalling had been shall be injected in a manner that completely fills all voids between aggregate and existing concrete.

3.2.02 Finishing-Crack Repair. When cracks and patched areas are completely filled, material shall be cured for sufficient time to allow removal of surface seal without any draining of run-back of material from cracks or patches.

Surface seal material and injection adhesive runs or spills shall be removed from concrete surfaces.

The face of crack and patched areas shall be finished flush to the adjacent concrete showing no indentations or protrusions caused by the placement of entry ports.

The procedure for filling field control testing core holes consists of using two-component bonding agent applied to the surfaces of cored holes followed by application of grout mix placed by hand trowel, thoroughly rodded and tamped in place, and finished to match color, finish and texture of existing concrete to the satisfaction of the Engineer. Materials and procedures for filling testing core holes shall be submitted to and approved by the Engineer before proceeding with this work.

3.2.03 Finishing-Spalling Repair. Contractor shall trowel smooth all spall-repaired areas until initial cure, with material no longer movable.

Contractor shall stone grind all protruding repaired surfaces.

3.2.04 Gravity Feed Grout. Pour neat Sikadur 35, Hi Mod LV into vee-notched crack as indicated in Project Drawings. Continue placement until completely filled.

3.3 FIELD QUALITY CONTROL.

3.3.01 Core Testing. It is imperative that no reinforcing steel be cut during coring.

3.3.02 Initial Cores. The Contractor shall obtain three 4 inches (10.2 cm) diameter initial core samples in the first one hundred lineal feet of crack repaired and one core for each one hundred lineal feet (30.5 m) thereafter. The cores shall be for full crack depth and taken from locations as selected by the Engineer. The Contractor shall provide at no additional expense to the Owner the following labor, materials, and services required for core sampling and testing of additional cores as directed by the Engineer.

Preparation, handling, storage and transportation of concrete core test specimens will be as directed by the engineer. The contractor will provide suitable containers for the storage, curing and transportation of test specimens as well as provide suitable storage for test equipment and other items required for sampling and testing.

Initial cores will be tested to determine the degree of penetration and the bond strength. Testing of initial core samples will be performed by the Contractor at the Contractor’s expense. Additional cores also called verification cores may be required if the initial cores fail. They will also be tested by the contractor at the Contractor’s expense.

3.3.03 Testing Methods Verification. Penetration will be tested by a visual examination.

Bond strength/compression test will be based upon a concrete failure prior to adhesive failure.

Penetration will be considered adequate when a minimum of 90 percent of the crack shall be full of crack sealing material.

Concrete failure shall occur before adhesive failure, or at stress of 6,500 psi (457 kg/sq cm) with no failure of either concrete or adhesive.

3.3.04 Evaluation of Acceptance of Tests. If the initial cores pass tests as specified above, sealant injection work at the area represented by the cores will be accepted.

If initial cores fail either by lack of penetration or bond strength, the work shall not proceed further until the area represented by the cores are reinjected, and retested for acceptance.

After re-work of areas represented by failed initial cores is complete, the Contractor shall obtain verifying cores, the number and location top is determined by the Engineer. Verifying cores shall be tested in the same manner as initial cores.

3.2.05 Pressure Test. The mixing head of the injection equipment shall be disconnected and the two-adhesive component delivery lines shall be attached to the pressure check device. The pressure check devices shall consist of two independent valved nozzles capable of controlling flow rate and pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the pressure build-up behind each valve. The valves on the pressure check device shall be closed and the equipment operated until the pressure gauge on each line reads 160 psi (11.25 kg/sq cm). The pumps shall be stopped and the pressure gauge shall not drop below 150 psi (10.55 kg/sq cm) within 3 minutes.

The pressure test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.

3.3.06 Ratio Test. The mixing head of the injection equipment shall be disconnected and the two adhesive components shall be pumped simultaneously through the ratio check device. The ratio check device shall consist of two independent, valved nozzles capable of controlling back pressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the back pressure behind each valve. The discharge pressure shall be adjusted to 160 psi (11.25 kg/cm^2) for both adhesive components. Both components shall be simultaneously discharged into separate calibrated containers. The amounts discharged into the calibrated containers simultaneously during the same time period shall be compared to determine that the volume/discharged conforms to the manufacturers recommended ratio for applicable material.

3.3.07 Test Reports. At all times during the course of the work the Contractor shall keep complete and accurate records of the pressure and ratio test specified above, available to the Engineer.

In addition, the Engineer, may, at any time with or without prior notification to the Contractor, request the Contractor to conduct the tests specified above in the presence of the Engineer.

End of Section

SECTION 03800

CONCRETE REPAIR

PART 1 - GENERAL

1.1 SCOPE. This section shall be used for structural repairs for concrete. This includes all labor, materials, equipment, and incidentals required to repair and refinish or otherwise modify for reuse, parts of existing structures, piping, pipe supports, equipment, and finishes after demolition and removal work is performed, as indicated on the Drawings or as specified. This shall include, but not be limited to, cutting, or enlarging and finishing new and existing openings, pipe, pipe supports, steel work and the like as required to complete the work included in the Contract.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM A82, “Steel Wire, Plain, for Concrete Reinforcement.”

ASTM A615/A615M, “Deformed and Plain Billet Steel Bars for Concrete Reinforcement.”

ASTM A996/A996M, “Rail Steel and Axle – Steel Deformed Bars for Concrete Reinforcement.”

ASTM C33, “Specifications for Concrete Aggregates.”

ASTM C150, “Portland Cement.”

ASTM C404, “Aggregates for Masonry Grouts.”

ASTM C882, “Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear.”

ASTM D638, “Test Method for Tensile Properties of Plastics.”

ASTM D695, “Compressive Properties of Rigid Plastics.”

ASTM D790, “Flexural Properties Of Unreinforced And Reinforced Plastics And Electrical Insulating Materials.”

AWS D1.4 (American Welding Society), “Structural Welding Code for

Reinforcing Steel."

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. Company specializing in manufacturing products specified in this section with minimum five (5) years documented experience.

1.3.02 Applicator Qualifications. A company specializing in concrete repair with minimum five (5) years documented experience and approved by manufacturer.

1.4 SUBMITTALS. The Contractor shall submit for approval, prior to any installation in the work, complete data on the materials proposed to be used in the work for doweling and grouting, including setting plans, and if requested, samples.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. For concrete bonding adhesive use Concresive Liquid LPL by BASF, or equal.

For non-shrink, natural aggregate grout, use Master Flow 928 by BASF, or equal.

For non-shrink, metallic aggregate grout, use Embeco 885 by BASF, or equal.

For structural repairs, use Embeco S Series from BASF or equal.

PART 3 – EXECUTION

3.1 INSTALLATION. All pipe, equipment, and supports shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.

In setting steel supports and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 inch (2.5 cm) for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and to be as inconspicuous as possible in the completed work.

Where such procedure is impracticable, the method of placing grout shall be as approved by Engineer. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, and if necessary, given a burlap-rubbed finish.

In grouting pipe sleeves in new or existing wall openings, special precautions shall be taken to ensure a complete filling of space with a dense waterproof grout in complete contact with the sleeve, its waterstop, and the existing concrete. The existing wall reinforcing that was cut in making the opening shall be replaced and supplemented as necessary and as detailed on the Drawings, to maintain the structural integrity of the original wall. Approved vibrating equipment and methods shall be employed to ensure a dense and complete watertight closure in the walls. Prior to placing grout, the prepared surface of the opening and the exterior surface of the pipe sleeve shall receive an application of epoxy bonding agent in accordance with the manufacturer's recommendations.

Openings made in existing slabs or walls shall be cut to the required finished size. The cut surface shall receive an application of Concresive Liquid LPL concrete bonding adhesive by BASF or approved equal.

The Contractor shall be responsible for providing adequate temporary supports for all floor and roof slabs while making the required alterations and for leaving such temporary supports in place until grout attains sufficient strength.

3.1.01 Modifying or Repairing Existing Concrete. Remove concrete to the depths shown or required. Roughen contact surfaces by chipping, waterblasting, sandblasting, scarifying, or other approved methods. Thoroughly clean the surface, removing loose particles and dust.

Cut off projecting reinforcement when required to provide at least 1 inch (2.5 cm) cover. Where shown, reinforcement shall be bent across cut face and covered with new concrete.

Thoroughly wash the roughened concrete surface and keep the surfaces saturated for at least 6 hours before placing new concrete. An epoxy bonding compound as specified may be used in lieu of saturating surface for 6 hours.

Repair mortar, where required, shall be placed to a thickness slightly in excess of the finished surface and shall be steel-trowel-finished, flush with the adjacent surface.

When the finish surface is not specified to be coated, the color of new concrete in the exposed surfaces shall match the color of the existing adjoining concrete as closely as possible.

3.1.02 Connections, New Concrete to Existing Concrete. Unless otherwise noted on the Drawings, No. 5 dowels set 6 inches (15.2 cm) into the concrete, and projecting 24 inches on center shall be used.

Where it is necessary to expose existing reinforcement, the reinforcing rods shall be cleaned by wire brushing and new reinforcement shall be hooked into existing reinforcement and lapped or welded as directed. Reinforcing rods shall have at least 3/4 inch (1.9 cm) clearance around each bar.

Preparation of concrete surfaces: Surfaces must be clean and sound. Surfaces may be dry, damp, or wet, but free of standing water. Remove dust, laitance, grease, curing compound, impregnations, waxes, foreign particles, and disintegrated materials by mechanical abrasion methods such as sandblasting. Steel must be sandblasted to the appropriate finish.

If the concrete surfaces are sound and it is only necessary to remove laitance, grease, or dust, the Contractor may, with the prior written approval of the Engineer, forego sandblasting and wash the concrete with a degreasing and etching chemical applied in accordance with the manufacturer's (PROSOCO, Inc., Kansas City, KS, or approved equal) written instructions and as stipulated in the Specifications hereinafter.

Degreasing and etching chemicals shall not contain pigments. Color shall be Water White. Flash point shall be above 150 degrees F (65.6 degrees C). Weight/gallon shall be 9.0 pounds (1.08 kg/l). Composition and materials shall be a blend of organic and inorganic acids with a special solvent system incorporating wetting agents for emulsification.

To apply degreasing and etching compound, pre-wet concrete surfaces with clean water. Brush concentrated cleaner onto concrete surface. Let stand 3 to 4 minutes and reapply, brushing stained areas vigorously. Rinse off with fresh water applied at a minimum pressure of 800 psi (56.25 kg/cm^3) and a minimum volume of 5 gallons (18.93 l) per minute.

3.1.03 Openings in Concrete. Where openings are required for pipes, thimbles for gates, gate stems, or other installations in existing concrete structures, the Contractor shall cut the existing concrete within the limits required, as shown on the Drawings or as specified, expose the existing reinforcing steel, and perform the work in such a manner as to prevent damage to the existing adjacent structures or equipment.

Where concrete is cut to provide openings for gate stems, pipe sleeves shall be accurately installed and grouted in place in an approved manner.

The exposed reinforcement shall be cleaned by wire brushing, then cut and bent to permit the installation, and finally bent around the new pipe or thimble. Additional reinforcement shall be provided as shown on the Contract Drawings for typical reinforcing details of openings in walls and slabs, except as otherwise shown, specified or required.

After installation of pipelines and thimbles, etc., the existing concrete shall be prepared as specified above, and the void between the outside of the pipe or thimble and the existing concrete shall be filled with non-shrink grout.

3.1.04 Grouting Under Equipment Bases, Base Plates, and Structural Members. Where grout is required under equipment bases, base plates, structural supports, non-shrink grout shall consist of factory premixed non-metallic, non-catalyzed grout such as Master Flow 928 Grout by BASF or equal. For additional information, refer to Master Specification Section 3600, Grout.

End of Section

INDEX

DIVISION 4 – MASONRY

SECTION 04065

MASONRY MORTAR AND GROUT

PART 1 – GENERAL

1.1 SCOPE. This section includes mortar and grout for all masonry work.

1.2 GENERAL.

1.2.01 Coordination.

1.2.02 Governing Standards.

ASTM (American Society for Testing and Materials) C94/C94M - Ready-Mixed Concrete.

ASTM C143/C143M – Test Method for Slump of Hydraulic Cement Concrete

ASTM C144 – Aggregate for Masonry Mortar

ASTM C150 – Portland Cement

ASTM C207 – Hydrated Lime for Masonry Purposes

ASTM C270 – Mortar for Unit Masonry

ASTM C387 – Packaged, Dry, Combined Materials for Mortar and Concrete.

ASTM C404 – Aggregates for Masonry Grout

ASTM C476 – Grout for Masonry.

ASTM C780 - Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

ASTM C1019 – Test Method for Sampling and Testing Grout.

ASTM C1314 – Compressive Strength of Masonry Prisms

ASTM C1329 - Mortar Cement.

ASTM C1357 - Methods for Evaluating Masonry Bond Strength.

ASTM E329 – Specification for Agencies Engaged in the Testing and/or

Inspection of Materials Used in Construction.

Masonry Standards Joint Committee (MSJC) Code/American Concrete Institute (ACI) 530/American Society of Civil Engineers (ASCE) 5/The Masonry Society (TMS) 402 – Building Code Requirements for Masonry Structures

MSJC Specification/ACI 530.1/ASCE 6/TMS 602 – Specifications for Masonry Structures.

1.3 QUALITY ASSURANCE. Perform work in accordance with MSJC code and specifications or as indicated on the drawings.

1.3.01 Testing. Sampling, testing and reporting will be performed by an acceptable testing agency conforming to the applicable requirements of ASTM E329 and this section.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit design mix required.

Submit complete plan of procedure before starting construction when grouting is to be placed in temperatures less than 40 degrees F (4 degrees C).

Submit mortar manufacturer’s instructions for each type of mortar or grout provided.

1.4.02 Certifications. Manufacturer shall certify that products meet or exceed specified requirements.

1.4.03 Samples. Submit 2 samples of mortar, illustrating mortar color and color range.

1.4.04 Test Reports. Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270. Test and evaluation reports shall conform to ASTM C780 for aggregate ratio and water content, air content, consistency and compressive strengths. Submit reports on grout indicating conformance of grout to property requirements of ASTM C476 and test and evaluation reports to ASTM C1019.

1.5 DELIVERY, HANDLING AND STORAGE. Store cementious materials in a place and manner to exclude moisture and contaminants. Deliver and store aggregates in a manner to avoid segregation or contamination with other aggregate size fractions or other materials.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide products from Blue Circle Cement, Medusa Cement Co., SGS Solomon Colors, The Quikrete Companies, or an approved equal.

2.2 MATERIALS. Portland Cement shall be ASTM C150, Type I or II.

Mortar Cement shall be ASTM C1329, Types M or S.

Premix Mortar shall be ASTM C387, Type M or S.

Mortar and grout aggregates shall be fine aggregate MDOT Type 2NS.

Hydrated Lime shall be ASTM C207, Type S, SA, N, NA.

Water shall be clean and potable.

Admixtures are not permitted.

Mortar for structural masonry shall be ASTM C270, Type M, S or N.

Mortar for non-structural masonry shall be ASTM C270, Type M, S, N or O.

Pointing Mortar shall be ASTM C270, Type N or O.

Stain resistant pointing mortar shall be one part Portland cement, 1/8 part hydrated lime, and two parts graded (80 mesh) aggregate, proportioned by volume. Add aluminum tristearate, calcium stearate, or ammonium stearate equal to 2 percent of Portland cement by weight. Use stain resistant pointing mortar where maximum stain or soil resistance are needed for pointing mortar where used with materials such as glazed unit masonry.

Mortar for glass unit masonry shall be ASTM C270, Type S or N.

Pointing mortar for glass unit masonry shall be ASTM C270, Type O with maximum 2 percent ammonium stearate or calcium stearate per cement weight with beach silica sand aggregate.

Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use. Add water in amounts necessary to obtain a mortar of the consistency required for the work. Achieve uniformly damp sand immediately before the mixing process. Mortar may be remixed but shall not be retempered or used after it has begun to set.

Table 1 – Typical Mortar Mix Formulas By Volume

Mortar Type	*Minimum Compressive Strength at 28 Days (psi)*	*Masonry Cement*	*Portland Cement*	*Hydrated Lime*	*Damp, Loose Aggregate*
M (High Strength)	2500	1(Type II) -	1 1	- 0 - ¼	2 ¼ to 3 times the sum of cement & lime volumes used.
S (Medium High Strength)	1800	1 (Type II) -	½ 1	- ¼ - ½	
N (Medium Strength)	750	1 (Type II) -	- 1	- ½ - 1 ¼	
O (Medium Low Strength)	350	1 (Type I or II) -	- 1	- 1 ¼ - 1 ½	

Grout for non-structural masonry shall be 2,000 psi (13789.6 kPa) mixed in accordance with ASTM C476 fine coarse grout.

Grout for structural masonry shall be 2,500 psi (17237 kPa) mixed in accordance with ASTM C476 fine coarse grout.

Fine and Coarse grouts are used with low lift and high lift grouting techniques. Both grout types may be used on the same Project.

If grout is transit mixed, mix grout in accordance with ASTM C94, modified to use ingredients complying with ASTM C476.

If grout is mixed onsite, thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476. Add water in amounts necessary to obtain a grout of the consistency required for the work. Grout may be remixed but shall not be retemerped or used after it has begun to set.

In certain conditions where a highly fluid grout is required, the Engineer may specify a grout composed of cement, fly ash and water. The cement to ash ratio may vary from 1:1 to 1:3, depending on the stiffness required.

PART 3 – EXECUTION

3.1 EXAMINATION. Request inspection of spaces to be grouted. After inspection, wet surfaces, install mortar and grout.

3.2 PREPARATION. Apply bonding agent to existing concrete and masonry surfaces.

Maintain materials and surrounding air temperature at maintain 50 degrees F (10 degrees C) or above prior to, during, and 48 hours after completion of work. Conform with MSJC specification regarding weather protection.

3. 3 INSTALLATION. Install mortar and grout in accordance with MSJC specification. Work grout into cavities to eliminate voids and clean concrete grout spaces of excess mortar and debris.

3.3.01 Grout Installation. Set reinforcing steel and anchors in required positions and secure against displacement before grouting is started. Place grout in cores and/or collar joints while fluid and before initial set has taken place. Puddle or vibrate grout into place. Place grout in such a way as to prevent segregation of materials. Pour grout fluid enough to flow into all crevices of grout spaces leaving no voids. Grout beams over openings in one continuous operation. Grout vertical cores in maximum of 5 feet (1.5 m) lifts. Stop grout pours 1 1/2 inches (3.8 cm) below a mortar joint, except at top of wall. Where bond beams are used stop grout pour 1/2 inch (1.3 cm) below top. Use metal lath, mortar, or special units to confine grout to area required. Do not use materials which may inhibit bond or are combustible. Use acceptable cold weather precautions in placing and curing of grout when temperature is less than 32 degrees F(0 degrees C). Follow requirements of Section 04300 for Low-Lift and High-Lift Grouting.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. Test grout mixes in accordance with ASTM C1019 for compressive strength, and in accordance with ASTM C143 for slump.

Test flexural bond strength of mortar and masonry units to ASTM C1357; test in conjunction with masonry unit sections specified.

Test compressive strength of mortar and masonry to ASTM C1314; test in accordance with masonry unit sections specified.

End of Section

SECTION 04216

GLASS UNIT MASONRY

PART 1 - GENERAL

1.1 SCOPE. This Section includes: A. Glass block, hollow. (For solid glass block, refer to section 04300, Unit Masonry assemblies).

1.2 GENERAL.

1.2.01 Related Sections. Related Sections include the following:

A. Section 05500 - Metal Fabrications: Steel channels, sills, lintels, and jambs.

1.2.02 References.

B. ASTM A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

C. ASTM A 153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.

E. ASTM C 150 - Standard Specification for Portland Cement.

F. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.

G. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

H. ASTM D 1187 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.

I. ASTM D 1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.

J. ASTM E 163 - Standard Methods of Fire Tests of Window Assemblies.

K. CAN 4-S106 - Fire Test of Window and Glass Block Assemblies.

L. UL 9 - Standard for Fire Tests of Window Assemblies.

1.3 SUBMITTALS

A. Submit under provisions of Section 01080.

B. Product Data: Manufacturer's literature on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Verification Samples:
1. Two glass block units of each type specified, showing size, design, and pattern of faces.
2. Representative samples of panel reinforcing, panel anchors, expansion strips, and sealant, as required for project.

D. Fire Test Reports: Submit documents verifying glass block units are classified for the specified fire exposure according to ASTM E 163, CAN 4-S106, or UL 9 "Fire Tests of Window Assemblies." Label cartons of tested units with appropriate UL label.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging in clean, cool, dry area until ready for installation.

B. Protect opened cartons of glass block against windblown rain or water run-off with tarpaulins or plastic covering.

1.5 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install glass block units when temperature is 40 degrees F (4 degrees C) and falling.

1.6 WARRANTY

A. Glass Block Units: Limited 5 year warranty on product only.

PART 2 - PRODUCTS

3.1 ACCEPTABLE MANUFACTURERS: Pittsburgh Corning Corporation, which is located at: 800 Presque Isle Dr. ; Pittsburgh, PA 15239-2799; Toll Free Tel: 800-624-2120; Tel: 724-327-6100; Fax: 724-325-9704; Email: request info; Web:

www.pittsburghcorning.com, or approved equal.

3.2 MATERIALS

3.2.01 Glass Block: PC Standard Premiere Series block; hollow; 3-7/8 inches (98 mm) thick.

3.2.02 Physical Properties:

Face Size: Actual face size is 1/4 inch (6 mm) less than nominal.
Weight Installed With Mortar: 20 lb/sq ft (98 kg/sq m).
Thermal Conductance (U Value): 0.51 Btu/hr sq ft deg F (2.9 W/sq m K); winter night.
Thermal Resistance (R Value): 1.96 deg F hr sq ft/Btu (0.35 (K sq m)/W).
Visible Light Transmission: 75 percent.
Shading Coefficient: 0.65.
Fire Rating: 45 minute rated window assemblies for panels in masonry walls up to 120 sq ft (11 sq m) with maximum height or width of 12 feet (3658 mm); and for panels in non-masonry walls up to 94 sq ft (9 sq m) with maximum height or width of 10.75 feet (3277 mm); rating does not apply to all 12 inch (305 mm) by 12 inch (305 mm) blocks.
Sound Transmission: No rating for sizes not square.
Pattern: DECORA.
Face Size: 8 inches (203 mm) by 8 inches (203 mm), nominal.

PART 3 - EXECUTION

3.1 EXAMINATION.

Do not begin installation until substrates have been properly prepared.

If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

Verify that structural members supporting glass blocks are designed for maximum deflection of L/600 under installed load.

Verify that panel anchors or channels for support at head and jambs are properly installed.

3.2 PREPARATION

Clean surfaces thoroughly prior to installation.

Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

Install in accordance with manufacturer's instructions with glass block set in full mortar bed with joint reinforcing at 16 inches (406 mm) on center and in joints immediately above and below openings.

Paint sills of all panels with heavy coat of asphalt emulsion and dry for minimum two hours before first mortar bed is placed.

Make provision for expansion and movement at jambs and heads of all panels; do not allow structural loads to bear on glad blocks.

Mix mortar and apply in accordance with manufacturer's recommendations.

3.4 CLEANING

Remove excess sealer from glass surfaces immediately following application.

Remove excess mortar from faces of glass block at time joints are struck or tooled.

3.5 PROTECTION

Protect installed products until completion of project.

Maintain temperature of glass unit masonry above 40 degrees Fahrenheit (4 degrees Celsius) for first 48 hours after construction.

Touch-up, repair or replace damaged products before Substantial Completion.

End of Section

SECTION 04300

UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 SCOPE. This section covers building masonry, unit masonry assemblies, glass unit masonry, concrete masonry units, bricks, reinforcement anchorage, and all accessories and appurtenances.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) A82 - Steel Wire, Plain for Concrete Reinforcement.

ASTM A153/A153M - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A167 – Stainless and Heat Resisting Chromium-Nickel Steel Plate, and Strip.

ASTM A480/A480M – General Requirement for Flat-Rolled Stainless Steel Plate, Sheet, and Strip.

ASTM A615/A615M – Deformed and Plain Billet Steel Bars for Concrete Reinforcement.

ASTM A635/A635M – Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot-Rolled

ASTM A641 – Zinc-Coated (Galvanized) Carbon Steel Wire.

ASTM A951 – Masonry Joint Reinforcement.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM C32 – Sewer and Manhole Brick (Made from Clay or Slate).

ASTM C55 – Concrete Test Methods for Brick.

ASTM C67 – Test Methods Sampling and Testing Brick and Structural Clay

Tile.

ASTM C90 - Load-Bearing Concrete Masonry Units.

ASTM C126 – Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.

ASTM C129 - Non-Load Bearing Concrete Masonry Units.

ASTM C140 – Test Methods of Sampling and Testing Concrete Masonry Units and Related Unites.

ASTM C144 – Aggregate for Masonry Mortar.

ASTM C150 – Portland Cement.

ASTM C207 – Hydrated Lime for Masonry Purposes.

ASTM C216 – Facing Brick (Solid Masonry Units Made from Clay or Shale.

ASTM C270 - Mortar for Masonry Purposes.

ASTM C404 – Aggregates for Masonry Grout.

ASTM C476 - Grout for Masonry (Solid Masonry Units Made from Clay or Shale).

ASTM C568 – Limestone Dimension Stone.

ASTM C612 – Mineral Fiber Block and Board Thermal Insulation.

ASTM C744 - Prefaced Concrete and Calcium Silicate Masonry Units.

ASTM D226 – Asphalt-Saturated Organic Felt used in Roofing and Waterproofing.

ASTM D226 - Asphalt Saturated Organic Felt used in Roofing and Waterproofing.

ASTM D1056 - Flexible Cellular Materials-Sponge or Expanded Rubber.

ASTM D2000 - Rubber Products in Automotive Applications.

ASTM D2240 – Test Method for Rubber Property-Durometer Hardness.

ASTM E119 - Fire Tests of Building Construction and Materials.

Cleaning Brick Masonry; Technical Notes on Brick Construction, No. 20 Revised H; Brick Institute of America (BIA).

NCMA-TEK 45 - Removal of Stains from Concrete Masonry Walls; National Concrete Masonry Association.

Masonry Standards Joint Committee (MSJC) Code/American Concrete Institute (ACI) 530/American Society of Civil Engineers (ASCE) 5/The Masonry Society (TMS) 402 – Building Code Requirements for Masonry Structures.

MSJC Specification ACI 530.1/ASCE 6/TMS 602 – Specifications For Masonry Structures.

1.3 QUALITY ASSURANCE. Perform work in accordance with MSJC Code and MSJC Specification.

1.3.01 Installer Qualifications. Installer shall be company specializing in performance work of this section with minimum of five years of documented experience.

1.3.02 Fire Rating. Where fire-rated masonry construction is indicated or required, provide materials and construction methods identical to those of assemblies tested in accordance with ASTM E119 for hourly ratings required. Provide evidence acceptable to governing authority that proposed construction complies with performance requirements.

1.3.03 Grout Tests. Employ an independent testing agency approved by the Engineer to test grout prior to sample wall construction, in accordance with ASTM C1019, for compatibility with each masonry unit.

Determine grout mix that provides slump between 8 and 11 inches (20.32 cm and 27.94 cm) and meets the strength requirements contained in Section 04065 based on the unit coverage area and weather conditions.

Submit grout mix showing the pounds (kg) of Portland cement/lime, gallons (liters) of water, pounds (kg) of fine aggregate, pounds (kg) of coarse aggregate, and allowable time of mix per batch.

1.3.04 Tolerances. Variation from plumb shall not exceed the following tolerances in vertical elements, including surfaces of walls, columns, and arises:

¼ inch (6.4 mm) in 10 feet (3.05 m).

3/8 inch (9.5 mm) in one story height, or 20 feet (6.10 m), whichever is less, except 1/4 inch (6.4 mm) for external corners, expansion joints, and other highly conspicuous vertical elements.

½ inch (1.27 cm) in 40 feet (12.19 m) or more.

Plus or minus 1/4 inch (6.4 mm) in 10 feet (3.05 m), 1/2 inch (1.27 cm) maximum, for vertical alignment of head joints.

Variation from level shall not exceed the following construction tolerances for bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal elements:

¼ inch (6.4 mm) in one bay or in 10 feet (3.05 m) maximum.

½ inch (1.27 cm) in 20 feet (6.10 m) or more.

Variation from plan lines shall not exceed the following horizontal construction tolerances for related portions of columns, walls, and partitions:

½ inch (1.27 cm) in any bay or in 20 feet (6.10 m) maximum.

¾ inch (1.9 cm) in 40 feet (12.19 m) or more.

Variation in cross section shall not exceed the following construction tolerances for thickness of walls and other masonry elements:

Minus 1/4 inch (6.4 mm).

Plus 1/2 inch (1.27 cm).

Variation in mortar joint thickness shall not exceed the following construction tolerances for thickness of mortar joints:

Bed joints: Plus or minus 1/8 inch (3.2 mm).

Head joints: Minus 1/4 inch (6.4 mm), plus 3/8 inch (9.5 mm).

1.4 <u>SUBMITTALS</u>.

1.4.01 <u>Drawings and Data</u>. Submit shop drawings showing gaskets at all masonry conditions and locations, annotating each profile and its dimension. Also submit shop drawings showing building expansion joints at all masonry conditions and locations, annotating each profile, its dimensions and color. Submit published data from manufacturers of products and accessories specified, indicating compliance with requirements.

Submit shop drawings for reinforcing bars in masonry walls".

1.4.02 Certifications. Submit statement of compliance for masonry units specified by reference to standard specifications that the units have been tested within 6 months of date for receipt of bids. Include results of efflorescence tests where required by the standard specification.

Submit a written description of the cold weather and hot weather construction procedures based on the project requirements specified.

1.4.03 Samples. Furnish samples for approval of all proposed masonry units and accessories prior to delivery of materials to the site. Include submit sample panel, or five units showing extreme range of color and texture.

Include plain and decorative concrete masonry units, glazed concrete masonry units, face brick, each shape, worked and cored, and glass masonry units as applicable.

Submit sample of wall reinforcement 18 inches (45.72 cm) in length, showing at least 2 cross joints, actual size of each type, and location.

Submit sample of anchors and ties (actual size of each type and location), control joint filler, and gaskets (actual size of each type and location).

Submit sample of mortar color.

1.4.04 Mock-up. Prior to commencement of exposed masonry work, erect sample panel (10’ x 13’4”) to serve as standard of appearance and workmanship throughout construction period.

Build at location and to design as indicated on drawings, or as otherwise directed by the Engineer.

When directed, demolish and remove mock-ups from Project site. Accepted mock-ups in undisturbed condition at time of Substantial Completion may become part of completed work.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver, handle, and store masonry units by means which will prevent mechanical damage and deterioration due to moisture, temperature changes, and contamination by other materials. Store masonry units off the ground in a dry location, covered and protected from the elements.

Provide protection which will limit moisture absorption of concrete masonry units to the maximum allowable percentage specified for Type I units at a relative humidity which is normal for the project site.

Protect cementitious materials from precipitation and absorption of ground moisture.

Store masonry accessories to prevent corrosion, dirt accumulation, and other deterioration.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.1.01 Allowable Working Stresses in Unreinforced Unit Masonry.

	Type M	*Type S*	*Type M or Type S Mortar*				*Type N*		
Material	*Compression*[1]	*Compression*[1]	*Shear or Tension in Flexure* [2 3]		*Tension in Flexure* [4]		*Compression*[1]	*Shear or Tension in Flexure* [2 3]	
Special inspection required	No	No	Yes	No	Yes	No	No	Yes	No
Solid brick masonry									
4500 plus psi	250	225	20	10	40	20	200	15	7.5
2500-4500 psi	175	160	20	10	40	20	140	15	7.5
1500-2500 psi	125	115	20	10	40	20	100	15	7.5
Solid concrete unit masonry									
Grade A (N)	175	160	12	6	24	12	140	12	6
Grade B (S)	125	115	12	6	24	12	100	12	6
Grouted masonry									
4500 plus psi	350	275	25	12.5	50	25			
2500-4500 psi	275	215	25	12.5	50	25			
1500-2500 psi	225	175	25	12.5	50	25			
Hollow unit masonry	170	150	12	6	24	12	140	10	5
Cavity wall masonry solid units [5]									
Grade A or 2500 psi plus	140	130	12	6	30	15	110	10	5
Grade B or 1500-2500 psi	100	90	12	6	30	15	80	10	5
Hollow units [5]	70	60	12	6	30	15	50	10	5
Stone masonry									
Cast stone	400	360	8	4	-	-	320	8	4
Natural stone	140	120	8	4	-	-	100	8	4
Gypsum masonry	20	20	-	-	-	-	20		
Unburned clay masonry	30	30	8	4	-	-			

[1]Allowable axial or flexural compressive stresses in pounds per square inch gross cross-sectional area (except as noted). The allowable working stresses in bearing directly on concentrated loads may be 50 percent greater than these values.
[2]This value of tension is based on tension across a bed joint, i.e., vertically in normal masonry work.
[3]No tension allowed in stack bond across head joints.
[4]The values shown here are for tension in masonry in the direction of running bond, i.e., horizontally between supports.
[5]Net area in contract with mortar or net cross-sectional area.

2.2 MATERIALS.

2.2.01 Brick Masonry Units. Face Brick that is 4 inch (10.16 cm) in size shall comply with ASTM C216 SW FBS.

Provide specially molded units as required to meet conditions indicated, unless standard units can be sawn to produce the same effect. Do not use standard units in any configuration, which exposes cores.

Provide color of brick, texture, and physical properties as selected by Engineer. Brick for underground masonry applications shall conform to ASTM C32 or C55 as applicable and shall be placed where indicated on the drawings.

2.2.02 Concrete Masonry Units. Concrete Block standard units with nominal face dimensions of 16 inches (40.6 cm) long and 8 inches (20.3 cm) high shall be 15 5/8 by 7 5/8 inches (39.7 by 19.4 cm) actual size, with nominal thicknesses as indicated on drawings for various locations.

Provide special block types where required for corners, control joints, headers, lintels, and other special conditions, whether or not specifically indicated on the drawings as special.

Outside corners shall be bullnose units except where otherwise indicated.

All units exposed to the exterior shall be manufactured with integral water repellent.

Manufacturer shall be Rheomix 235 or approved equal.

Hollow load-bearing units shall be ASTM C90, Type I, Moisture-controlled units, of normal weight, exposed faces shall be manufacturer's standard color and texture.

Non-load-bearing units shall be ASTM C129, hollow, Type I, Moisture-controlled units, of medium weight.

Solid load-bearing units shall be ASTM C90, Type I, Moisture-controlled units of normal weight. Exposed faces shall be manufacturer's standard color and texture.

Acoustical Concrete Masonry Units shall be sound absorbing units equal to Acousta-Wal Type IVRF; Trenwyth Industries, Inc. Provide standard units with nominal face dimensions of 16 inches (40.64 cm) long and 8 inches (20.32 cm) high (15-5/8 by 7-5/8 actual), with nominal thicknesses as indicated on drawings for various locations.

Slots shall be funnel shaped.

Fillers shall be factory inserted fiberglass.

Septum shall be metal, laminated to fiberglass fillers.

2.2.03 Decorative Concrete Masonry: Units shall conform to ASTM C90 normal weight. Burnished units shall be Best Block Bagley, or approved equal. Split face units shall Best Block Bagley, or approved equal.

2.2.03b: Glazed Block: Furnish light weight concrete block units that conform to ASTM C90, with glazed faces conforming to ASTM C216, Grade G. All exposed surfaces shall be glazed unless noted. Provide special shapes as necessary and as shown on drawings. Use Premier Glazed units; Spectra Glaze or approved equal. Color: match architect's sample.

2.2.04 Hollow Glass Block. Provide non-load-bearing blocks compressing two half-blocks of pressed glass fused to produce a partial vacuum, with manufacturer's standard factory-applied edge coating.

Glass block shall have pattern similar to Vistabrik, stipple finish by Pittsburgh Corning, PC Glass Block and be nominal 3 inches (7.62 cm) thick and 8 inches (20.32 cm) square. Edge coating color shall be Manufacturer's standard white color. Provide product of Pittsburgh Corning Corporation or approved equal.

2.2.05 Stone Trim Units. Shall be Indiana monolitic limestone as quarried in Lawrence, Monroe and Owen Counties, Indiana, complying with ASTM C568, Category II (medium density). Color shall be buff, the grade shall be select, and the finish shall be smooth as defined by the Indiana Limestone Institute of America (ILI).

Cut stone accurately to shape and dimensions indicated, with exposed faces dressed true, beds and joints at right angles to face; comply with ILI fabricating tolerances.

2.2.06 Lintel. Plainly mark tops of all lintels to show number and size of bars.

Precast Concrete Lintels shall be free from cracks and chipped or broken edges, with uniformly smooth, dense surface; exposed to view; surfaces resembling the texture of adjacent concrete masonry units or burnished masonry units; minimum compressive strength of lintels at 28 days, 3000 psi (210.92 kg/sq cm); 7 5/8 inches (19.36 cm) high; and reinforced as follows, unless otherwise indicated.

Up to 8 feet (7.44 m) span - four no. 3 bars.

8 to 9 feet (2.44 to 2.74 m) span - four no. 4 bars.

9 to 10 feet (2.74 to 3.05 m) span - four no. 5 bars.

2.2.07 Joint Materials. Compressible joint filler shall be Williams Products, Inc. “Williams Expand-O-Foam 1380 Series” or approved equal; closed cell expanded polyethylene, shape as indicated.

Air seal gasket shall be Williams Product, Inc. “Williams Neoprene Type NN1, 1040 Series” or approved equal; shape as indicated and size required to provide 25 percent compression.

Control joint filler shall be Williams Products, Inc., “Slot Seal Standards 2015-3” or approved equal; synthetic rubber complying with ASTM D2000 designation 3BA 810, having durometer hardness of 80 when tested in accordance with ASTM D2240, and having minimum shear strength of 540 psi (37.97 kg/cm^2).

Isolation material shall be mineral fiber board complying with ASTM C612, Class 1, nominal density 2 to 4 lbs. per cubic foot (32.04 to 64.07 kg per cubic meter).

2.2.08 Reinforcing Materials. Reinforcing bars for bond beams, vertical wall reinforcement and lintels shall be ASTM A615, Grade 60; bars larger than No. 2, deformed, round.

Horizontal wall reinforcement shall be fabricated from cold drawn steel wire complying with ASTM A82 and zinc coated in accordance with ASTM A153, Class B-2 (1.50 oz. per square foot (458 grams per square meter) coating, with 9 gage (3.9 mm) longitudinal and cross wires, furnished in flat sections not less than 10 feet (3.05 m) in length with out-to-out spacing of longitudinal wires 1 3/4 inches (4.45 cm) less than nominal width of the back-up wythe of concrete masonry wall. Locate longitudinal wire 1 1/4 inches (3.18 cm) back from the face of the weather wythe and 1/2 inch (1.27 cm) in from interior face of back-up wall.

Wall reinforcement for cavity walls shall be 3-wire ladder type without moisture drip. Use AA Wire Products Co. “Tri-Lok”, Dur-O-Wal, Inc. “Ladur Type Trirod”, Hohmann & Barnard, Inc. “Tri-Mesh”, or approved equal.

Wall reinforcement for cavity walls with coursing in facing offset from coursing in backing shall be 2-wire truss type with 3/16 inch (4.8 mm) (wire adjustable ties for facing wythe, designed to allow no more than 1/16 inch (1.6 mm) movement perpendicular to the wall, between the eyelet and pintle leg, having maximum coursing offset vertically of 1/2 inch (1.27 cm), having relation between location of eyelet and face of cavity wall insulating as indicated. Use AA Wire Products Co. “Adjustable Blok-Trus”, Dur-O-Wal, Inc. “Dur-O-Eye”, Hohmann & Barnard, Inc. “Adjusto-Flex-Truss-Mesh”, or approved equal.

Wall reinforcement for single wythe walls and partitions shall be truss type without moisture drip. Use AA Wire Products Co. “Blok-Trus”, Dur-O-Wal, Inc “Dur-O-Wal

Truss", Hohmann & Barnard, Inc. "Trus-Mesh", or approved equal. Bar Positioner shall be 9 gage galvanized wire as manufactured by AA Wire Products Co; Dur-O-Wal, Inc; Masonry Corp. of America; or as approved.

2.2.09 Joint Reinforcement and Anchorage Materials. Anchors and ties shall be steel zinc-coated in accordance with ASTM A153, Class B-2 (1.50 oz. per square foot (458 grams per square meter)) coating, of approved types for each application. Wire mesh ties for furring shall be 1/2 inch (1.27 cm) mesh of 16 gage diameter coated steel wire, length not less than 20 inches (50.8 cm), and width 1 1/2 inches (3.81 cm) less than width of masonry units.

Metal ties shall be minimum 7/8 inch (2.22 cm) wide, 22 gage (0.9 mm) coated steel sheet, corrugated or crimped and in length as indicated.

Dovetail anchors, Type 1 shall be 6 gage (5.0 mm) coated steel wire, triangular in shape, nominal size indicated, with coated steel wire or bar dovetail clip. Type 2 shall be 1 inch (2.54 cm) wide, 16 gage (1.6 mm) coated steel sheet, straight or with a 1 inch (2.54 cm) turndown profile, unless otherwise indicated.

Rigid steel anchors shall be 3/16 inch (4.8 mm) coated steel, 1 1/4 inches (3.18 cm) wide, turned up 2 inches (5.08 cm) at one end and down 2 inches (5.08 cm) at other end, length required to fit into cells of concrete masonry units.

Flexible anchors shall be 6 gage (50 mm) coated steel wire, triangular in shape, nominal size indicated, with coated steel wire welded to structural elements.

Channel slot anchors shall be Dur-O-Wal. "D/A 903" or as approved, using 11 gage coated steel slotted channels and anchors. Type 1 shall be "D/A 911", 1/8 x 1 1/4 inch (3.2 mm x 3.18 cm) coated steel anchors, length as indicated. Type 2 shall be "D/A 913", 1/8 x 1 1/4 inch (3.2 mm x 3.18 cm) coated steel anchor with end bent down 1 inch (2.54 cm), length as indicated. Type 3 shall be "D/A 918-921", 6 gage (50 mm) coated steel wire, triangular in shape, nominal size indicated, with coated steel clip.

Extended channel slot anchor shall be Dur-O-Wal, Inc. "D/A 902" or as approved, with 11 gage (3.1 mm) coated steel legs of length required to project anchor beyond depth of field-applied fireproofing.

Zinc-rich Paint shall be ZRC Products Co. "Z.R.C." or other acceptable product complying with DOD-P-21035A.

Use products from AA Wire Products Company, Dur-O-Wal, Inc., Heckmann Building Products, Inc., Hohmann and Barnard, Inc., Masonry Reinforcing Corporation of American, National Wire Products Industries, Inc., or an approved equal.

2.2.10 Miscellaneous Masonry Accessories. Expansion joint strips shall be neoprene filler strips complying with ASTM D1056, Classification 2 A1, capable of 35 percent compression and sized for specific conditions indicated.

Premolded control joints shall be strips sized for standard sash block and designed to allow movement while maintaining lateral stability, and meet ASTM D2000, Styrene-butadiene rubber compound; Designation 2AA-805.

Bond Breaker Strips shall be ASTM D226, Type I; No. 15 asphalt felt.

Sealant and Backer Rod shall be as specified in Division 7.

Wall drainage system shall be 1 inch (2.54 cm) thick x 10 inch (2.54 cm) high x continuous high density polyethylene or nylon mesh in trapezoidal configuration designed to allow moisture to flow downward in the cavity. Manufacturer to be “The Mortar Net” by Mortar Net USA, Ltd., 1-800-664-6638.

2.2.11 Metal Flashing and Trim. Stainless steel sheet shall meet ASTM A167, Type 302 or 304 sheets or strips, dead soft fully annealed, 2D finish per ASTM A480.

Prefinished aluminum sheets shall be ASTM B209 manufacturer’s standard alloy and temper for indicated applications. Finish 20 percent “Kynar 500” or “Hylor 5000 resin finish over epoxy primer.

Metal flashing joint sealant shall be non-drying, non-skinning, non-oxidizing, butyl sealant complying with AMA Specification 808.3, such as Protective Treatments, Inc. “PTI 707”.

Interlocking flashing shall be Cheney Flashing Co. “3-Way Flashing”, 16 oz (454 g), high strength copper sheet or 0.015 inch (0.4 mm) thick stainless steel sheet, deformed to provide a keyed mortar bond.

Reglet for flashing in concrete wall shall be Keystone Flashing Company “Keystone Simplex” formed of 16 oz (454 g) copper or 0.015 inch (0.4 mm) thick, dead soft stainless steel, complete with prepunched nail holes at 12 inches (30.48 cm) on center and required matching nails or screws.

Metal flashing under masonry coping shall be the interlocking type, profile as indicated with a double fold turned down. Provide for 3 inch (7.62 cm) lap joints.

Metal flashing under masonry bearing on foundation walls to protect waterproofing from masonry construction shall be profile as indicated. Provide for 2 inch (5.08 cm) lap joints, cleaned and bonded with metal joint sealant. Use pop-rivets at lap joints. Seal pop-rivets.

Metal flashings other than interlocking type shall be 10 oz (284 g) lead-coated copper or 0.010 to 0.015 inch (0.25 to 0.4 mm) stainless steel, profile as indicated. Provide for 2 inch (5.08 cm) minimum lap joints, cleaned and then bonded with metal flashing joint sealant. Use pop-rivets at lap joints. Seal pop-rivets.

Form ends of non-continuous flashing at locations such as over openings and adjacent to doors to provide a one inch (2.54 cm) high dam (end dam). Construct front dams where indicated to provide a one inch (2.54 cm) high dam (front dam).

Solder external and internal corners as required to make a continuous membrane.

Before soldering stainless steel, clean, roughen and pretin edges of sheet metal to be soldered. Remove all flux residue from acid type flux by scrubbing, neutralizing with ammonia.

2.2.12 Masonry Cleaner. Shall be general-purpose acidic cleaner designed for new masonry surfaces, comprised of blended acids combined with special wetting systems, and approved by manufacturer of masonry units.

2.2.13: Burnished Block Sealer: Use sealer as recommended by block manufacturer to enhance color and luster to match architect's sample.

PART 3 - EXECUTION

3.1 PREPARATION. Refer to ACI 530.1 for erection of masonry, including bracing and protection, and for installation of reinforcement and metal accessories.

3.1.01 Cold Weather Construction. Perform all masonry construction so that the in-wall components will not be below 39 degrees F (4 degrees C) for a minimum of 24 hours after placement.

Do not work with or upon frozen materials.

Do not lay masonry units which have wet surfaces or units which are below freezing. Remove ice or snow from masonry bed by careful application of heat. Remove masonry damaged by freezing.

When air temperature is 40 degrees F (4.4 degrees C) to 32 degrees F (0 degrees C) maintain mortar temperature between 40 degrees F (4.4 degrees C) and 120 degrees F (48.9 degrees C) by heating water or sand before mixing. Protect masonry from rain or snow for at least 24 hours by covering with weather-resistive membrane.

Do not lay masonry units when air temperatures are below 32 degrees F (0 degrees C).

For grouted construction when minimum anticipated night time temperature is 32 degrees F (0 degrees C) or less, in addition to procedures above, heat grout materials to 90 degrees F (32.2 degrees C) to produce in-place grout temperature of not less than 70 degrees F (21.1 degrees C) at end of work day. Retain protective blankets or enclosures for not less than 48 hours. Period may be reduced to 24 hours if Type III Portland cement is used.

Clay masonry units must be wetted before laying because initial rate of absorption (suction) is greater than 1 gram per square inch (6.45 cm^2) per minute. (ASTM C67). If the surface temperature is above 32 degrees F (0 degrees C), sprinkle with water heated to 70 degrees F (21.1 degrees C) or above, just before laying. If the surface temperatures is below 32 degrees F (0 degrees C), sprinkle with water heated to 130 degrees F (54.4 degrees C) or above, just before laying.

Do not heat water for mortar or grout to more than 160 degrees F (71.1 degrees C).

3.1.02 Hot-Weather Protection. Cover or shade masonry units and mortar materials and use cool water for mortar whenever ambient air temperature is 90 degrees F (32.2 degrees C) or greater. At air temperatures of 85 degrees F (29.4 degrees C) or above, if relative humidity is less than 30 percent or wind is in excess of 15 miles per hour (24.1 kmh), provide protection by immediately covering newly constructed walls, by providing windbreaks, or by using fog spray to reduce rate of evaporation.

The maximum temperature of water used for mortar shall be 110 degrees F (43.3 degrees C).

3.1.03 Mixing Mortar. Mix mortar according to approved mortar mix. Do not employ hand mixing without approval by the Engineer.

3.2 INSTALLATION.

3.2.01 Placement. Lay masonry plumb, true to line, with level courses and joints of uniform width and in thickness and pattern indicated. Lay exposed masonry in running bond except where other bonds are indicated. Tap wills lightly with hammer in each course at end of each workday. Before resuming, clean exposed surfaces and remove loose masonry units and mortar.

Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other Work. Lay hollow masonry units with face shell bedding on head and bed joints. Coursing for concrete masonry units shall be one unit and one mortar joint to equal 8 inches (20.32 cm). Coursing for brick units shall be tree units and three mortar joints to equal 8 inches (20.32 cm).

Adjust each unit to its final position in the wall while the mortar is still soft and plastic. Remove any unit which is disturbed after mortar has been placed in the head and bed joints and compressed into final position and relay the unit with fresh mortar. Avoid over-plumbing and pounding of corners and jambs to fit.

Build chases as indicated or as required to accommodate cabinets, pipes, ducts, conduits or other work provided under other Master Specification Sections. Keep chases free of mortar and debris.

For cutting of masonry units, employ masonry mechanics with masonry saws.

Leave openings in masonry as required for subsequent installation of equipment and services. Make openings in designated locations and in exact size required, if known; otherwise; leave rough openings in approximate size required and complete masonry work after installation of equipment, matching adjoining masonry.

Where fresh masonry joins masonry that is set, clean and lightly wet the contact surface of the set masonry. Remove loose mortar.

Solidly fill spaces around metal door frames and other built-in items with mortar. Rake out joint between frame and masonry for caulking, unless otherwise indicated. Unless other conditions are specifically detailed, solidly grout cores for at least 24 inches (60.96 cm) below bearing plates, lintels, and similar features and conditions.

Build in items required to be embedded in masonry in a manner to avoid cutting and patching. At locations where built-in items are to be connected to hollow unit masonry, solidly grout cores to provide adequate anchorage.

Unless otherwise indicated, construct partitions from floor to underside of floor or roof construction above, less specified separation from structure.

Provide an open joint 1/2 inch (1.27 cm) wide minimum, unless otherwise indicated, with isolation material to separate masonry units of non-bearing walls and partitions from contact with structural components.

3.2.02 <u>Cavity walls</u>. Keep cavity clean and free of mortar droppings by using wood strips resting on adjustable ties and lifted up as construction progresses.

Provide weep holes in the weathering face at 24 inch (60.96 cm) spacing at bottom of cavity and in first course above flashing, full height and width of head joint, and free of mortar droppings. Use a form that starts at flashing back dam and extends out past the weathering face a minimum of one inch (2.54 cm) for ease of removal. After wall is completed between shelf angle supports, remove weep hole forms.

Provide a cavity a minimum of 4 inches (10.16 cm) wide, composed of a nominal 2 inch (5.08 cm) cavity and 2 inches (5.08 cm) of cavity wall insulation, unless otherwise indicated, to separate facing and backing. Bond facing and masonry backing together with horizontal wall reinforcement or adjustable ties.

Apply parge material Type 1 (vapor retarder) to the cavity side face of concrete masonry backing, 3/16 inch (4.8 mm) thick, trowled to a smooth, dense surface as follows, when cavity wall insulation is used:

Apply primer by roll or brush at a rate of 1 1/2 gallons per 100 square feet 0.61 liters per square meter. Let dry to touch.

Apply parge in one coat at a rate of 5 gallons per 100 square feet 2.04 liters per square meter).

Apply an additional coat where face of masonry backing varies to provide a flush surface for installation of insulation. Vapor permeance in grains per square foot per hour when tested in accordance with ASTM E96 shall be 0.0077 initially and 0.000 after 90 days.

Impale cavity wall insulation into the parge without back voids and with tightly butted joints and with vertical joints staggered. Install cavity wall insulation full height of wall against inner wythe between ties, leaving 2 inch (5.08 cm) minimum cavity between insulation and outer wythe.

Provide running center bond pattern, unless otherwise indicated or specified.

Anchor walls and partitions to abutting structure at a maximum spacing of 16 inches (40.64 cm). Anchor to new concrete with dovetail anchors and to steel structure with Type 2 or 3 channel slot anchors as indicated, or with flexible anchors for interior locations as indicated. Anchor to existing concrete with Type 3 channel slot anchors, and to underside of floor or roof deck with Type 1 channel slot anchors.

Anchor walls and partitions to steel beams at 32 inch (81.28 cm) spacing. Where anchors are welded to structural steel, coat the welds with zinc-rich paint.

Tie intersections of load-bearing and fire-rated walls together with rigid steel anchors, at maximum vertical spacing of 4 feet (1.22 m) with vertical legs embedded in coarse grout.

Bearing course under floor joists and slabs and under lintels less than 8 feet (2.44 m) in span length shall be 4 inches (10.16 cm) in height of solid masonry, filled-cell blocks or solid-top blocks, except where bond beam is indicated. Bearing course under beams, girders and trusses and under lintels 8 feet (2.44 m) or more in span length shall be solid masonry or concrete as indicated, but not less than 8 inches (20.32 cm) in height.

Provide horizontal wall reinforcement in all walls as indicated. Locate horizontal wall reinforcement at maximum vertical spacing of 16 inches (40.64 cm) and in first and second bed joints above and below openings, extending 24 inches (60.96 cm) beyond opening. Provide prefabricated horizontal wall reinforcement tees and angles at intersecting walls and partitions, unless control joints are indicated. Discontinue horizontal wall reinforcement at any vertical brick expansion joint and any concrete masonry control joint.

Provide continuous vertical rod reinforcement in walls, of size and location as indicated. If the use of continuous rods is impractical, lap the splices 48 bar diameters, in addition to the 48 inch (1.22 m) lift requirement and tie with wire. Length of vertical wall reinforcement includes lift and lap requirement.

Lap joint reinforcements ends minimum 6”.

Place vertical wall reinforcement plus or minus 1/2 inch (1.27 cm) from center of cell and not closer than one inch (2.54 cm) from any web. Install vertical bar positioners at 54 inch (1.37 m) vertical spacing. Remove any loose material from the cells of concrete masonry. Solidly fill cells that contain reinforcing with coarse grout, in maximum lifts of 48 inches (1.22 m).

Vibrate or puddle coarse grout in cells of concrete masonry at each intermediate lift to consolidate material placement. Terminate the top of grout at intermediate lifts half the height of the unit for keying of the adjacent lift.

3.2.03 Masonry Construction. Provide special shapes required for a complete installation.

Use hollow load-bearing units for walls and partitions, unless otherwise specified.

Use solid load-bearing units or concrete building brick at the top of partitions terminating below ceiling or below exposed roof or floor construction.

Use solid load-bearing or hollow load-bearing fire-rated units for walls or partitions indicated to be 6 inch (15.24 cm) unplastered and indicated or required by the authority having jurisdiction to have a 2 hour fire resistance rating.

Lightly wet previously laid clay masonry units, which have rate of absorption of more than 1 gram per square inch per (6.45 cm^2) minute (ASTM C67), before laying fresh masonry.

In surfaces exposed to view, tool mortar joints, when thumbprint hard, with a round jointer.

Construct head joints for hollow units by buttering both the unit being placed and the adjoining unit with mortar.

Cut mortar joints flush in furnaces to be plastered or covered with other construction. Remove mortar protrusions into cells or cavities to be reinforced and filled.

In glazed concrete masonry, rake setting mortar 1/4 inch (6.4 mm), allow to dry and tuckpoint raked joints. Where masonry is scored to simulate stack bonding, align the joints and scores vertically and tuckpoint the raked joints and scores at the same time. Finished mortar color shall be uniform.

Provide bond beams as indicated, constructed as a continuous course of bond-beam units filled with coarse grout and reinforced with two No. 4 bars, unless otherwise indicated. Lap bars a minimum of 48 bar diameters at splices.

In 2 hour fire rated partitions, fill cells of 6 inch (5.24 cm) units, which contain junction boxes or other penetrations with coarse grout.

Support grout in filled cells with wire mesh ties or metal lath.

Provide lintels for openings in masonry walls of types indicated at all openings. Notch lintels abutting columns or concrete walls to fit flush with both legs of seat angle.

3.2.04 Brick Masonry Construction. Before laying brick, check the units for color, chippage, dimensional tolerances and warpage.

Provide face brick for brick exposed to view. Use concrete building brick only for concealed portion of brick walls and partitions.

Add moisture to brick having absorption rates, determined in accordance with ASTM C67, in excess of 25 grams per 30 square inch (193.55 cm^2) per minute sufficiently so that the rate of absorption when the brick is laid does not exceed this amount.

Insure that each unit is nearly saturated, surface dry when laid.

Lay each horizontal course complete unless topping off is required for construction purposes. If topping off is required, rack the brick back 1/2 brick length in each course. Toothing, or projecting end stretchers of alternate courses, will not be permitted, except upon written approval.

Lay brick with full bed and head mortar joints, unless otherwise specified. Deep furrowing of the bed joints of mortar is not permitted.

Exposed “J” joints shall be 3/8 inch (9.5 mm) thick, tooled with round jointer. Joints below grade shall be trowel-pointed. Other joints not tooled shall be flush cut.

Tie veneer facing to backing as specified in ACI 530.1. Ties to masonry backing shall be metal, except where horizontal wall reinforcement is required.

Anchors to concrete backing shall be dovetail anchors. Anchors to structural steel shall be channel slot anchors welded to structural steel and coated with zinc-rich paint after welding or fastened with powder actuated fasteners.

Anchors to existing concrete and exiting masonry shall be Type 3 channel slot anchors, attached with two fastener per tie. Anchor to metal studs (interior condition) shall be channel slot anchors attached to metal studs with hollow wall expansion fasteners.

3.2.05 <u>Masonry Expansion and Control Joints</u>. In interior masonry walls and partitions, provide vertical control joints where indicated but not exceeding a maximum spacing of 40 feet (12.19 m). Form control joint with metal sash jamb blocks both sides of joint and fill with control joint filler. Extend control joints through bond beams.

Where control joints are located at the end of lintels, install building paper in bed joint of lintel. Install control joint at both ends of lintel for the remaining height of concrete masonry unit. Use a control joint filler engaged into sash type units to provide lateral support for the masonry wall.

For exterior masonry movement joints outer wythe – brick expansion joints shall be of width indicated and kept free of mortar by installation of compressible joint filler.

Keep horizontal joints under shelf angles or plate supports free of mortar, and install compressible filler as indicated.

For inner wythe – concrete masonry control joint, install air seal gasket in joint in backing and where indicated. Compress gasket 25 percent into joint. Install control joint filler between sash type units in backing of cavity walls. Control joint width shall be 3/8 inch (9.5 mm) plus or minus 1/16 inch (1.6 mm), set by installation of control joint filler.

3.2.06 <u>Cavity Wall Construction</u>. Connect wythes of cavity walls with individual ties staggered in alternate courses and spaced at 16 inches (40.64 cm) on center maximum vertically and 16 inches (40.64 cm) on center maximum horizontally.

3.2.07 Glass Unit Masonry. Lay glass unit masonry on full bed joints and with head joints completely filled; lay units plumb and level, with mortar joints of uniform thickness.

Do not use steel tools to tap units into position, and do not allow glass masonry units to come into contact with metal framing or reinforcing.

3.2.08 Anchoring Masonry. Structural framing anchorage; anchor masonry to structural framework at points of adjacency, and as follows.

Maintain open space of 1 inch (2.54 cm) or more between face of framing member and masonry elements.

Fasten anchors to structure and embed in mortar joints, at 16 inches (40.64 cm) o.c. as masonry is laid.

3.2.09 Installing Reinforced Unit Masonry. Clean reinforcement bars of loose rust. Do not use bars which have rusted excessively or which have bends or kinks not shown on drawings.

Secure reinforcement accurately at locations indicated and to avoid displacement; minimum spacing between bars or to masonry surfaces shall be bar diameter or 1/4 inch (6.4 mm) for fine grout and 1/2 inch (1.27 cm) for coarse gout, whichever is greater.

Provide lapped splices of minimum size indicated or permitted by governing code at locations shown; other methods or locations must be approved by the Engineer.

Construct formwork where required for temporary support of reinforced masonry, bracing as required to maintain proper shape during placement and curing of grout and adequately tight to avoid grout leakage.

3.2.10 Low-Lift Grouting. In hollow unit masonry construction, limit low-lift grouting to maximum wall height of 5 feet (1.52 m) per lift. Vertical cores to be grouted shall have minimum clear dimension between sides of the core of 2 inches (5.08 cm) and clear area of 8 square inch (51.61 cm^2).

In double and multiple wythe masonry construction to be low-lift grouted, limit the height of the outer wythe to 18 inches (45.72 cm) before grouting, and the height of the inner wythe to 8 inches (20.32 cm) before grouting.

Collar joints to be grouted shall have minimum clear dimension of ¾ inch (1.9 cm) plus the width required for reinforcing bars in the joint. Where collar joint exceeds 4 inch (10.16 cm) width, embed masonry units in grout so that ¾ inch (1.9 cm) of grout surrounds sides and ends of each unit. Do not embed units or pieces of units, which are less than 10 cubic inches (163.87 cm^3).

Remove misplaced grout immediately and clean affected areas.

3.2.11 High-Lift Grouting. Grout hollow unit masonry in accordance with this section when erected to height in excess of 5 feet (2.52 m) before grouting. Vertical cores to be grouted shall have minimum clear dimension of 3 inches (7.62 cm) and clear are of 10 square inches (64.52. cm^2)

Grout collar joints in double and multiple wythe masonry when erected to height in excess of 8 inches (20.32 cm) before grouting in accordance with this section. Collar joints shall have minimum clear dimension of 2 inches (5.08 cm) plus diameter of horizontal reinforcing bars in joint.

In double or multiple wythe masonry, tie wythe together with metal ties anchored in mortar bed joints and spaced not more than 24 inch (60.96 cm) on center horizontally and 18 inches (45.72 cm) on center vertically, or use joint reinforcement in alternate courses. Where stacked bond and metal ties are used, reduce horizontal and vertical spacing to 12 inch (30.48 cm).

Provide cleanout openings at 12 square inch minimum are opposite each vertical bar at bottom course or in foundation wall.

Clean core and collar joints of mortar droppings and foreign material, position reinforcement, and close cleanout openings before grouting starts.

Place vertical barriers consisting of masonry units and mortar in bond beam type hollow units and in collar joints to be grouted at 30 feet (9.15 m) maximum to limit horizontal flow of grout.

Pour grout in 5 feet (1.52 m) lifts maximum allowing minimum of 30 minimum and maximum 1 hour before pour before plasticity is lost. Reconsolidation may occur as next lift is poured.

Do not erect masonry to a height more than 80 times, minimum clear grout space before grouting with a maximum of 30 feet (9.14 cm) unless otherwise acceptable.

Do not use high-lift grouting method until masonry units have been in place 3 days minimum, unless permitted.

Do not permit water or foreign material to fall in grout space while grout is being placed and curing.

Remove misplaced grout immediately and clean affected areas.

3.2.12 Installing Concealed Masonry Flashing. Whether or not specifically indicated, install flashing at all conditions such as lintel and shelf angles, where the downward flow of any water within the masonry will be interrupted, so that such water will be diverted to the exterior. Extend flashings full width at such obstructions and at least 4 inches (10.16 cm) into adjoining masonry, or turn up to form watertight pan at non-masonry construction. Remove or cover protrusions or sharp edges on substrates which could puncture flashings. Place flashings on sloped mortar bed; seal lapped ends and penetrations of flashing before covering with mortar.

Extend metal flashings through exterior face of masonry and turn down to form drip.

Bring through-wall flashings completely through inner wythe and turn up where concealed by other construction; otherwise stop not more than 1/2 inch (1.27 cm) from inner face. Drop flashing at least 4 inches (10.16 cm) before bringing through outer wythe.

Turn up ends of flashing at least 2 inches (5.08 cm) at heads and sills to form a pan, and seal joints.

Seal all joints in flashing to assure watertight integrity. Seal deformed metal flashing at ends by lapping at least 2 inches (5.08 cm) and interlocking deformations. Install sealant at lapped edge. Lap end joints of flexible flashings at least 4 inches(10.16 cm); seal in accordance with manufacturer's instructions.

Provide weep holes in head joints of the first course of masonry immediately above concealed flashings. Space at intervals of 24 inches (60.96 cm) on center.

3.2.13 Installing Stone Units. Install all limestone units in compliance with Indiana Limestone Institute of America requirements and guidelines.

3.2.14 Masonry Trim Installation. For precast concrete and masonry combination, provide copings of length indicated, but not exceeding 5 feet (1.52 m).

Set copings in full beds of mortar 1/2 inch (1.27 cm) thick with no. 3 stainless steel rod embedded in mortar and discontinuous at joints, key in underside of opening filled solid with mortar, and bed joint tooled on roof side. Keep face of units clean and free of mortar. Provide 3/8 inch (9.5 mm) wide vertical joints, filled with 3/8 inch (9.5 mm) thick compressible joint filler compressed firmly in joint. Die cut filler to size so as to provide a recess along edges of joint 3/8 inch (9.5 mm) deep for sealing. Sealing is specified in Master Specification Section 07600, Caulking and Sealers. Rake out recess and keep completely free of mortar.

Set sills in full bed of mortar, unless otherwise specified. Set lugged sills with ends only embedded in mortar and balance of joint left open until finally pointed.

After setting, thoroughly dampen and point mortar joints flush. Point pen joints under lugged sills to a minimum depth of 1 inch (2.54 cm).

Form weep holes by omitting head joint, at a height of 2 5/8 inch (6.67 cm).

Reglets and other accessories shall be installed to receive flashing where indicated.

3.2.15 Repairing Masonry. Carefully remove areas of damaged masonry and replace with matching, undamaged units using mortar which matches original work.

During pointing remove mortar with visible holes or mortar which cannot be compacted properly because of hidden voids, and replace with fresh mortar, filling each joint completely and tooling to match adjacent work.

3.2.16 Protection. Cover tops of incomplete masonry elements with waterproof sheet material at end of each work day and when masonry work is not under way.

Secure weather protection in place with weights or by use of temporary fasteners.

Immediately remove mortar, soil, and other such materials from exposed masonry faces to prevent staining.

Prevent splashing and soiling of masonry near ground level by spreading sheet material to cover soil or masonry faces.

Protect horizontal masonry elements from mortar droppings.

Do not apply uniform floor or roof loads for at least 12 hours, or concentrated loads for at least 3 days, after completion of masonry elements.

3.2.17 Cleaning. Protect Limestone with clear sealant prior to cleaning of masonry.

Dry brush concrete masonry at the end of each day’s work and after final pointing. Clean masonry after mortar is thoroughly set and cured. Remove mortar spots and repair cracks. Cut out defective joints and repoint with mortar.

Scrape off adhered mortar particles by hand, using non-metallic tools.

Scrub precast concrete trim with soap and water, using fiber brushes, and rise with clean water from a hose.

Test cleaning methods on half of sample panel, leaving other half in original state.

Protect adjacent surfaces from cleaner with appropriate coating or polyethylene sheet.

Before applying cleaning solution, saturate masonry surfaces with water; rinse thoroughly immediately after cleaning.

Use bucket and brush hand-cleaning method described in BIA Technical Notes No. 20 Revised for brick masonry, using acidic cleaner applied in accordance with manufacturer's instructions.

Comply with directions of concrete unit masonry manufacturer and NCMA Tek Bulletin No. 45 for cleaning CMU.

3.2.18 Burnished Block Sealer: Apply field coat of Burnished Block sealer to clean and dry Burnished Block walls.

End of Section

SECTION 04811

CAVITY WALLS

PART 1 - GENERAL

1.1 SCOPE. This section includes double wythe cavity wall construction made with brick, structural clay tile, or decorative and prefaced concrete masonry units, or any combination of such units in which facing and backing are completely separated, except for the ties, which serve as bonding.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the following publications and standards.

(American Society for Testing and Materials) A153 – Zinc Coating (Hot-Dip) and Steel Hardware.

ASTM A615/A615M – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM A653/A653M – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A580/A580M – Stainless Steel Wire.

ASTM A666 – Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A641/A641M – Zinc-Coated (Galvanized) Carbon Steel Wire.

ASTM A951 – Masonry Joint Reinforcement.

ASTM B370 – Copper Sheet and Strip for Building Construction.

ASTM C34 – Structural Clay Load-Bearing Wall Tile.

ASTM C55 – Concrete Brick.

ASTM C56 – Structural Clay Non-Load Bearing Tile.

ASTM C62 – Building Brick (Solid Masonry Units Made From Clay or Shale).

ASTM C67 – Test Methods for Sampling and Testing Brick and Structural Clay Tile.

ASTM C73 – Calcium Silicate Brick (Sand-Lime Brick).

ASTM C90 – Load-Bearing Concrete Masonry Units.

ASTM C126 – Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.

ASTM C129 – Non-Load-Bearing Concrete Masonry Units.

ASTM C140 – Testing Methods of Sampling and Testing Concrete Masonry Units and Related Units.

ASTM C212 – Structural Clay Facing Tile.

ASTM C216 – Facing Brick (Solid Masonry Units Made From Clay or Shale).

ASTM C315 – Clay Flue Linings.

ASTM C530 – Structural Clay Non-Load-Bearing Screen Tile.

ASTM C652 – Hollow Brick (Hollow Masonry Units Made From Clay or Shale).

ASTM C744 – Prefaced Concrete and Calcium Silicate Masonry Units.

ASTM D226 – Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

Masonry Standards Joint Committee (MSJC) Code/American Concrete Institute (ACI) 530/American Society of Civil Engineers (ASCE) 5/The Masonry Society (TMS) 402 – Building Code Requirements for Masonry Structures.

MSJC Specification/ACI 530.1/ASCE 6/TMS 602 – Specifications for Masonry Structures.

1.3 QUALITY ASSURANCE. Perform work in accordance with MSJC code and specification.

1.3.01 Contractor's Qualifications. Employ an installer with a minimum of 5 years documented experience installing cavity walls. Submit evidence of experience, including a list of projects for which the work was similar in scope and quality to that specified.

1.3.02 Testing. Testing shall comply with testing provisions defined in MSJC.

Testing agency shall have a minimum of 5 years experience in performing concrete and masonry tests of type specified in this section and capable of performing testing in accordance with ASTM C140.

1.3.03 Source Quality Control. Perform quality control and inspection procedures to comply with applicable sections of MSJC specifications.

Conduct water absorption test on units in accordance with MSJC code.

1.3.04 Tolerances. Maximum variation from alignment of columns and pilasters shall 1/4 inch (6.4 mm).

Maximum variation from unit to adjacent unit shall be 1/16 inch (1.6 mm).

Maximum variation from plane of wall shall be 1/4 inch (6.4 mm) in 10 feet (3.05 m) and 1/2 inch (1.27 cm) in 20 feet (6.10 mm).

Maximum variation from plumb shall be 1/4 inch (6.4 mm) per story non-cumulative with a maximum of 1/2 inch (1.27 cm) in two stories or more.

Maximum variation from level coursing shall be 1/8 inch (3.2 mm) in 3 feet (91.44 cm), 1/4 inch (6.4 mm) in 10 feet (3.05 m), and 1/2 inch (1.27 cm) in 30 feet.

Maximum variation of joint thickness shall be 1/8 inch (3.2 mm) in 3 feet (91.44 cm).

Maximum variation from cross sectional thickness of walls shall be 1/4 inch (6.4 mm).

Maximum variation for steel reinforcement shall be plus or minus 1/2 inch (1.27 cm) when distance from centerline of steel to opposite face of masonry is 8 inches (20.32 cm) or less; plus or minus 1 inch (2.54 cm) when the distance is between 8 and 24 inches (20.32 and 60.96 cm); plus or minus 1 1/4 inch (3.18 cm) when the distance is greater than 24 inches (60.96 cm); and plus or minus 2 inches (5.08 cm) from the location along the face of the wall.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings prepared by or under the supervision of a professional engineer experienced in cavity walls. Shop drawings shall include unit shapes (elevations and sections), dimensions, finishes, reinforcement, joint, and connection details. Also include location, dimensional tolerances, details of anchorage devices that are embedded in or attached to wall structures, and any other items cast into wall panels. Show also the relationship to adjacent cavity wall components.

Submit data for decorative prefaced masonry units and fabricated wire reinforcement, anchors, ties, flashing, joint reinforcement, joint materials, and insulation.

1.4.02 Certifications. Manufacturer shall certify that products meet or exceed specified requirements.

1.4.0.3 Samples. Submit four samples each of decorative concrete masonry units, face brick, prefaced concrete masonry units and two samples of other units and accessories. Units shall illustrate color, texture and extremes of color range.

1.4.04 Mock-Up. Prior to installation, construct a cavity masonry wall into a panel sized 8 feet (2.44 m) long by 6 feet (1.83 m) high, which includes masonry, mortar and accessories. Do not proceed with installation of units until the mock-up unit has been approved. Approved mockup construction shall represent the standard of workmanship.

1.5 DELIVERY, STORAGE, AND HANDLING. Transport and store units in original packaging consistent with manufacture’s handling instructions in order to avoid damage. Support units during shipment on shock-absorbing material.

Store and protect units to prevent contact with soil, staining, and physical damage and do not store units directly on ground.

Store units, unless otherwise specified, on non-staining, resilient supports located in same position as when transported on firm, level, and smooth surfaces to prevent cracking, distortion, warping or other physical damage.

Place stored units so that identification marks are discernible and product can be inspected.

1.6 WARRANTY. Warrant the work for 5 years against defects in materials and workmanship resulting in warping, spalling or disintegration, and against other defects affecting the strength, durability or appearance of the work.

During this period, restore defective work to the standard of the contract documents, including all materials, labor, refinishing and other costs incidental to the work. Inspect the work within 24 hours after receipt of notice from the Engineer and immediately repair leaks in the work. Restore work found to be defective, as defined in the Contract documents, within 10 days after receipt of notice from Engineer.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Hot and cold weather requirements shall comply with MSJC Specification.

2.2 ACCEPTABLE MANUFACTURERS. Provide materials from Amcor Inc.; Best Block & Products, Inc.; Oldcastle Architectural Products; Shiely Masonry Products; Solite Corp.; Trenwyth Industries, Inc.; or approved equal. Local suppliers that carry some of these products include:

> American Brick Company, 27303 W. Eight Mile, Detroit, MI 48240, (313) 538-6636, (800) 248-8280
>
> Grace Masonry Products, 7221 W. Parkland Ct., Milwaukee, WI 53223, (800) 558-7066
>
> Master Builders, Inc., 23700 Chagrin Blvd., Cleveland, OH, (800) MBT-9990

2.3 MATERIALS.

2.3.01 Components. Face brick shall meet ASTM C216.

Building brick shall meet ASTM C62.

Hollow facing and building brick shall meet ASTM C652.

Sand-lime face brick shall meet ASTM C73.

Ceramic glazed face brick shall meet ASTM C126.

Clay load-bearing wall tile shall meet ASTM C34

Clay non-load-bearing tile shall meet ASTM C56.

Clay non-load-bearing screen tile shall meet ASTM C530

Clay facing tile units shall meet ASTM C212.

Hollow load-bearing concrete masonry units (CMU) shall be ASTM C90, Type I – Moisture Controlled.

Solid load-bearing concrete masonry units (CMU) shall be ASTM C90, Type I – Moisture Controlled.

Hollow or solid non-load-bearing concrete masonry units (CMU) shall be ASTM C129, Type I – Moisture Controlled.

Decorative concrete masonry units shall be ASTM C90, Type I – Moisture Controlled.

Prefaced concrete masonry units shall be ASTM C744 with resinous surfacing on ASTM C90 or ASTM C129 masonry units, Grade N, Type I – Moisture Controlled. Provide single or double faced units. Provide coved base units at first course above finished floor.

Concrete brick units shall be ASTM C55, Grade N, Type I – Moisture Controlled.

2.3.02 Accessories. Multiple wythe joint reinforcement shall be truss or ladder type; with moisture drip; adjustable type, hot dip galvanized to ASTM A641 Class 3 after fabrication, or cold drawn steel wire conforming to ASTM A951.

Reinforcing steel shall be ASTM A615 type, specified in Master Specification Section 03200, Concrete Reinforcement.

Wall ties shall be formed steel wire, thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A153.

Dovetail anchors shall be bent steel strap, galvanized to ASTM A153 finish.

Anchor bolts shall be headed, J-shaped or L-shaped.

Cooper shall be ASTM B370, cold rolled soft temper; natural finish.

Galvanized steel shall be ASTM A653 G90 finish core steel.

Stainless steel shall be ASTM A666, Type 304, soft temper; smooth finish.

Lap sealant shall be acrylic type as specified in Master Specification Section 07600, Caulking and Sealers.

Preformed control joints shall be rubber, neoprene or polyvinyl chloride material.

Provide with corner and tee accessories, cement fused joints.

Joint filler shall be closed cell polyvinyl chloride, polyethylene, polyurethane or rubber oversized 50 percent to joint width; self-expanding.

Building paper shall be ASTM D226, No. 15 asphalt saturated felt.

Cavity vents shall be molded polyvinyl chloride grilles, insect resistant.

Weep holes shall be formed using rope or leaving joint ungrouted. Tubes shall not be used.

Cleaning solution shall be non-acidic, not harmful to masonry work or adjacent materials.

Precast concrete lintels shall be as specified.

PART 3 – EXECUTION

3.1 INSPECTION. Verify that field conditions are acceptable and are ready to receive work. Verify items provided by other sections of work are properly sized and located. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION. Direct and coordinate placement of metal anchors to be supplied by concrete trade.

Deliver glazed prefaced units to project site in such quantities and at such times to assure continuity of installation.

Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent support.

3.3 INSTALLATION. Establish lines, levels, and coursing indicated. Protect from displacement.

Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.

3.3.01 Coursing of Concrete Masonry Units. Bond shall be running. Coursing shall be one unit and one mortar joint to equal 8 inches (20.32 cm). Mortar joints shall be concave.

3.3.02 Coursing of Brick Units. Bond shall be running. Coursing shall be three units and three mortar joints to equal 8 inches (20.32 cm). Mortar joints shall be concave.

3.3.03 Coursing of Prefinished Decorative Clay Tile Units. Bond shall be running. Coursing shall be one unit and one mortar joint to equal 8 inches (20.32 cm). Mortar joints shall be concave.

3.3.04 Placing and Bonding. Lay solid masonry units in full bed of mortar, with full head joints. Lay hollow masonry units with face shell bedding on head and bed joints. Buttering corners of joints or excessive furrowing of mortar joints are not permitted. Remove excess mortar as work progresses.

Interlock intersections and external corners.

Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and make adjustment and replace with new mortar. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges. Cut mortar joints flush where wall tile is scheduled, cement parging is required, resilient base is scheduled, cavity insulation vapor barrier adhesive is applied, or bitumen dampproofing is applied. Isolate masonry from vertical structural framing members with a movement joint. Isolate top of masonry from horizontal structural framing members and slabs or decks with compressible joint filler.

Lay clay tile flue linings vertical, bedded in mortar, immediately adjacent to concrete block clay tile units.

3.3.05 Weeps and Vents. Provide weeps and vents in outer wythe at 24 inches (60.96 cm) o.c. horizontally above through-wall flashing and at bottom of walls.

Do not permit mortar to drop or accumulate into cavity air space or to plug weeps. Build inner wythe ahead of outer wythe to receive cavity insulation air/vapor barrier adhesive.

3.3.06 Joint Reinforcement and Anchorage. Install horizontal joint reinforcement 16 inches (40.64 cm) o.c. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (40.94 cm) each side of opening. Place joint reinforcement continuous in first and second joint below top of walls. Lap joint reinforcement ends minimum 6 inches (15.24 cm). Embed anchorages in every second block or sixth brick joint. Reinforce joint corners and intersections with strap anchors 16 inches (40.64 cm).

3.3.07 Masonry Flashings. Extend flashings horizontally through outer wythe at foundation walls and at bottom of walls, turn down on outside face to form a drip. Turn flashing up minimum 8 inches (20.32 cm) and bed into mortar joint of masonry backing. Lap end joints minimum 6 inches (15.24 cm) and seal watertight. Turn flashing, fold, and seal at corners, bends, and interruptions.

3.3.08 Lintels. Install precast concrete lintels over openings. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled. Do not splice reinforcing bars. Support and secure reinforcing bars from displacement. Place and consolidate grout fill without displacing reinforcing. Allow masonry lintels to attain specified strength before removing temporary supports.

3.3.09 Grouted Components. Reinforce bond beam and pilaster as shown in drawings. Lap splices bar diameters required by code. Support and secure reinforcing bars from displacement. Place and consolidate grout fill without displacing reinforcing. At bearing locations, fill masonry cores with grout for a minimum 12 inches (30.48 cm) either side of opening.

Do not continue horizontal joint reinforcement through control and expansion joints.

Install preformed control joint device in continuous lengths. Seal butt and corner joints.

Form expansion joint by omitting mortar and cutting unit to form an open space.

3.3.10 Built-in Work. As work progresses, install built-in metal door and glazed frames, fabricated metal frames, window frames, wood nailing strips, anchor bolts, plates, and other items to be built-in the work and furnished by other sections. Install built-in items plumb and level. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout or mortar. Fill adjacent masonry cores with grout minimum 12 inches (30.48 cm) from framed openings. Do not build in materials subject to deterioration.

3.3.11 Cutting and Fitting. Cut and fit for chases, pipes, conduit, sleeves, electric ground. Coordinate with other sections of work to provide correct size, shape, and location. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.3.12 Cleaning. Remove excess mortar and mortar smears and replace defective mortar to match adjacent work. Clean soiled surface with cleaning solution, and use non-metallic tools in cleaning operations.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. Test each type of brick and clay tile unit in accordance with ASTM C67, using 5 random units for each 50,000 units installed.

Test each type of concrete masonry units in accordance with ASTM C140.

End of Section

SECTION 04813

MASONRY VENEER

PART 1 – GENERAL

1.1 SCOPE**.**

Section includes face brick, concrete masonry units, pre-faced glazed unit masonry, reinforcement, anchorage, and accessories.

1.2 GENERAL.

1.2.01 Coordination. Convene minimum one week prior to commencing Work of this section for a pre-installation meeting.

1.2.02 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

ASTM (American Society for Testing and Materials) A153/A153M – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A580/A580M – Stainless Steel Wire.

ASTM A641/A641M – Zinc Coated (Galvanized) Carbon Steel Wire.

ASTM A653/A653M – Steel Sheet, Zinc Coated, (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A666 – Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A951 – Masonry Joint Reinforcement.

ASTM B370 – Copper Sheet and Strip for Building Construction.

ASTM C55 – Concrete Brick.

ASTM C67 – Test Methods of Sampling and Testing Brick and Structural Clay Tile.

ASTM C73 – Calcium Silicate Face Brick (Sand-Lime Brick).

ASTM C90 – Load-Bearing Concrete Masonry Units.

ASTM C140 – Sampling and Testing Concrete Masonry Units, and Related Units.

ASTM C126 – Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.

ASTM C129 – Non-Load-Bearing Concrete Masonry Units.

ASTM C216 – Facing Brick (Solid Masonry Units Made From Clay or Shale).

ASTM C270 – Mortar for Unit Masonry.

ASTM C476 – Grout for Masonry.

ASTM C652 – Hollow Brick (Hollow Masonry Units Made From Clay or Shale).

ASTM C744 – Pre-faced Concrete and Calcium Silicate Masonry Units.

ASTM D226 – Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM E119 – Test Methods for Fire Tests of Building Construction and Materials.

MSJC (Masonry Standards Joint Committee) Code – ACI (American Concrete Institute) 530/ASCE (American Society of Civil Engineers) 5/TMS (The Masonry Society) 402 – Building Code Requirements for Masonry Structures.

MSJC Specification – ACI 530.1./ASCE (American Society of Civil Engineers) 6/TMS 602 – Specifications For Masonry Structures.

1.3 QUALITY ASSURANCE. Perform Work in accordance with MSJC Code and MSJC Specification. Comply with referenced unit masonry standard for cold-weather construction. Do not lay masonry units that are wet or frozen. Remove masonry damaged by freezing conditions.

1.3.01 Testing Laboratory Qualifications. To qualify for employment in performing tests and inspection specified in this Section, an independent testing laboratory must demonstrate to Engineer’s satisfaction, based on evaluation of submitted criteria conforming to ASTM C1093, that it has the experience and capability to conduct the testing indicated without delaying the progress of the Work.

1.3.02 Installer Qualifications. Company specializing in performing Work of this section with minimum five years documented experience.

1.3.03 Fire Performance Characteristics. Where indicated, provide materials and construction identical to those of assemblies whose fire resistance has been determined per ASTM E119 by a testing and inspecting organization, by equivalent concrete masonry thickness, or by another means acceptable to authorities having jurisdiction.

1.3.04 Single- Source Responsibility for Masonry Units. Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

1.3.05 Single-Source Responsibility for Mortar Materials. Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit data for decorative pre-faced masonry units, anchors, ties, flashings, and joint materials. submit certifying that products meet or exceed specified requirements.

Submit cold- and hot-weather construction procedures that show compliance with unit masonry standards.

1.4.02 Certifications. Submit data for firms and persons specified in “Quality Assurance” Article demonstrating their capabilities and experience. Include list of completed projects.

1.4.03 Samples. Submit two samples each of miscellaneous units, decorative concrete masonry units, face brick, pre-faced concrete masonry units, faced brick and/or pre-faced concrete masonry units, to illustrate color, texture and/or extremes of color ranges.

Colored masonry mortar samples for each color are required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.

Supply 20 each size, color, and type of glazed pre-faced units for repair stock.

1.4.04 Test Reports. Material test reports are required from a qualified independent testing laboratory employed and paid by the Contractor indicating and interpreting test results relative to compliance of mortar complying with property requirements of ASTM C270. Similar reports are required for grout mixes, including description of type, proportions of grout ingredients, and masonry units.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver masonry materials to project in undamaged condition.

Store masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.

Store cementitious materials off the ground, under cover, and in dry location.

Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS.

Best Block Co.

Oldcastle Architectural Products

Trenwyth Industries, Inc.

or Approved Equal.

2.2 COMPONENTS.

2.2.01 General. Comply with the following requirements applicable to each form of brick required. Provide special molded shapes where indicated and as follows:

For applications requiring brick of form, color, texture, and size on exposed surfaces that cannot be produced by sawing standard brick sizes.

For applications where stretcher units cannot accommodate special conditions including those at corners, movement joints, bond beams, sashes, and lintels.

Provide units without cores or frogs and with all exposed surfaces finished for ends of sills, caps, and similar applications that expose brick surfaces that otherwise would be concealed from view.

2.2.02 Hollow Brick. Meet requirements of ASTM C652.

Provide units of grade and minimum average net area compressive strength of Grade SW and 3000 psi.

Type HBX (for general use in exposed masonry requiring minimum variations in size and color ranges).

Provide bricks manufactured to the tolerances specified in ASTM C652.

2.2.03 Face Brick. ASTM C216, Type FBS, Grade MW/SW/NW; and color as selected by the Engineer.

2.2.04 Sand-Lime Face Brick. Meet ASTM C73, Grade SW/MW.

2.2.05 Ceramic Glazed Face Brick. Meet ASTM C126.

2.2.06 Hollow Load - Bearing Concrete Masonry Units (CMU). Meet ASTM C90, Type I – Moisture Controlled; normal weight.

2.2.07 Solid Load – Bearing Concrete Masonry Units (CMU). Meet ASTM C90, Type I – Moisture Controlled; normal weight.

2.2.08 Hollow Non-Load – Bearing Concrete Masonry Units (CMU). Meet ASTM C129, Type I – Moisture Controlled; normal weight.

2.2.09 Decorative Concrete Masonry Units. Meet ASTM C90, Type I – Moisture Controlled; color as selected.

2.2.10 Concrete Brick Units. Meet ASTM C55, Grade, Type I – Moisture Controlled; normal weight.

2.2.11 Joint Reinforcement. Truss or Ladder type; steel wire hot dip galvanized to ASTM A641 Class after fabrication, or cold drawn steel wire conforming to ASTM A951, stainless steel wire conforming to ASTM A951, or stainless steel conforming to ASTM A580 Type 304.

Provide joint reinforcement complying with requirements of referenced unit masonry standard.

Welded-wire units shall be prefabricated with deformed continuous side rods and shall have plain cross rods that run into straight lengths of not less than 10 feet (3.05 m), with prefabricated corner and tee units.

Subject to compliance with requirements, provide joint reinforcement by:

AA Wire Products Co.

Dur-O-Wal, Inc.

Heckman Building Products, Inc.

Or Approved Equal.

2.2.12 Strap Anchors. Bent steel shape, size as indicated, hot dip galvanized to ASTM A153 finish.

2.2.13 Wall Ties. Corrugated formed sheet metal, hot dip galvanized to ASTM A153 finish.

2.2.14 Wall Ties. Formed steel wire, adjustable, eye and pintle type, hot dip galvanized to ASTM A153 finish.

2.2.15 Dovetail Anchors. Bent steel strap, galvanized to ASTM A153 finish.

2.2.16 Nailing Strips. Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.

2.2.17 Weeps. Preformed plastic tubes, cotton wick filled or vents with sloping louvers with cotton rope.

2.2.18 Cavity Vents. Molded polyvinyl chloride grilles aluminum insect resistant.

2.2.19 Preformed Control Joints. Rubber, Neoprene or Polyvinyl chloride material. Provide with corner and tee accessories, heat or cement fused joints.

2.2.20 Joint Filler. Closed cell polyvinyl chloride, polyethylene, polyurethane or rubber oversized 50 percent to joint width; and self-expanding.

2.2.21 Building Paper. Meet ASTM D226, No. 15 or 30 asphalt saturated felt.

2.3 MISCELLANEOUS ANCHORS.

2.3.01 Anchor Bolts. Steel bolts shall comply with A 307, Grade A. Hex nuts shall comply with ASTM A563, where indicated. Provide flat washers. Hot-dip galvanized materials shall comply with ASTM A153, Class C. Utilize proper diameter and length as necessary. Nonheaded bolts shall be bent in manner indicated. Headed bolts shall be I – shaped or L – shaped.

2.4 EMBEDDED FLASHING MATERIALS.

2.4.01 Laminated Flashing. Manufacturer’s standard laminated flashing.

2.4.02 Copper-Fabric Laminate. Copper sheets of 5 oz weight per sq. ft. (1526 grams per square meter) shall be bonded with asphalt between 2 layers of glass fiber cloth. Use where flashing is fully concealed in masonry.

2.4.03 Adhesive for Flashing. Provide type recommended by manufacturer for proposed flashing material to be used as indicated.

2.4.04 Products. Subject to compliance with requirements. Products for copper fabric laminate flashing include:

“Copper Fabric,” Afco Products Inc.

“Type FCC-Fabric Covered Copper,” Phoenix Building Products.

“Copper Fabric Flashing,” Sandell Manufacturing Co., Inc.

“York Copper Fabric Flashing,” York Manufacturing, Inc.

or Approved Equal.

2.5 MISCELLANEOUS MASONRY ACCESSORIES.

2.5.01 Bond Breaker Strips. Asphalt-saturated organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).

2.5.02 Weep Holes. Vinyl Weep Hole/Vent shall be provided by one-piece offset T-shaped units formed to fit in a vertical mortar joint by injection molding of flexible wings to seal against ends consisting of a louvered vertical leg with flexible wings to seal against ends of masonry units, and top flap; in color approved by Engineer to match that of mortar.

Subject to compliance with requirements, provide “Williams-Goodco Brick Vent” by Williams Products, Inc. or equal.

2.6 MASONRY CLEANERS. Proprietary Acidic Cleaner of manufacturer’s recommended standard strength material shall be used. The general purpose of cleaner is designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces.

For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelates, and wetting agents by “Sure Klean Vana Trol,” ProSoCo, Inc. or approved equal.

For additional guidelines consult “Masonry Cleaning, Restoration, and Finishing”.

2.7 MORTAR AND GROUT MIXES.

2.7.01 General Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

Do not add calcium chloride to mortar or grout.

2.7.02 Mortar for Unit Masonry. Comply with ASTM C270, Property Specification for job-mixed mortar and ASTM C1142 for ready-mixed mortar.

Limit cementitious materials in mortar to Portland Cement and/or lime.

Use Type N for exterior, reinforced masonry, above-grade load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing and non-load-bearing partitions, reinforced masonry and for other applications where another type is not indicated.

2.7.03 Colored Pigmented Mortar. Select, mix and proportion pigments with other ingredients to produce color required to match Engineer’s sample.

2.7.04 Grout for Unit Masonry. Comply with ASTM C476 and referenced “Unit Masonry” standard and Master Specification Section 04065, Masonry Mortar and Grout.

PART 3 – EXECUTION

3.1 EXAMINATION. Verify that field conditions are acceptable and are ready to receive work.

Verify items provided by other sections of work are properly sized and located.

Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

For the record, prepare written report, endorsed by Contractor listing conditions detrimental to performance of unit masonry.

Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation.

Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION. Direct and coordinate placement of metal anchors supplied to other sections.

3.3 INSTALLATION. Comply with referenced unit masonry standard and other requirements indicated applicable to each type of installation included in the Work.

3.3.01 Thickness. Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

Build chases and recesses as shown or required to accommodate items specified in this and other Master Specification Sections. Provide not less than 8 inches (20.32 cm) of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.

Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.

Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

3.4 CONSTRUCTION TOLERANCES. Comply with construction tolerances of referenced unit masonry standard. Establish lines, levels, and coursing indicated, and maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.

3.5 PLACING AND BONDING. Lay solid masonry units in full bed of mortar, with full head joints. Lay hollow masonry units with face shell bedding on head and bed joints. Buttering corners of joints or excessive furrowing of mortar joints are not permitted. Remove excess mortar as Work progresses.
Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate location of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.

Lay out walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

Interlock intersections and external corners. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.

Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

Isolate top of masonry from horizontal structural compressible joint filler.

3.6 BONDING PATTERN FOR EXPOSED MASONRY. Lay exposed masonry in the following bond pattern. Do not use units with less that nominal 4-inch (10.16 cm) horizontal face dimensions at corners or jambs.

Lay one-half running bond with vertical joint in each course centered on units in courses above and below for brick with triple score concrete masonry units. One-quarter running bond for brick with single score.

Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches (5.08 cm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (10.16 cm) horizontal face dimensions at corners or jambs.

3.6.01 Stopping and Resuming Work. In each course, rack back ½-unit length for one-half running bond or 1/3-unit length for one-third running bond. Do not tooth in units. Clean exposed surfaces of set masonry, than wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

3.6.02 Built-In Work. As construction progresses, build-in items specified under this and other Master Specification Sections. Fill in solidly with masonry around built-in items.

Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

At exterior frames insert extruded polystyrene board insulation around perimeter of frame in thickness indicated but not less than ¾ inch (1.9 cm) to act as a thermal break between frame and masonry.

Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches (60.96 cm)) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.7 MORTAR BEDDING AND JOINING. Lay solid masonry units in full bed of mortar, with full head joints. Lay hollow masonry units with face shell bedding on head and bed joints. Buttering corners of joints or excessive furrowing of mortar joints are not permitted. Remove excess mortar as Work progresses.. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches (60.96 cm)) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated. Cut joints flush for masonry walls to be concealed or to be covered by other materials, unless otherwise indicated.

3.8 WEEPS AND VENTS. Provide weeps and vents in outer veneer at 24 inches (60.96 cm) on center horizontally above through-wall flashing, above shelf angles and lintels, at bottom of walls.

Form weep holes with products specified in this section. In air spaces insulated cavities cover cavity/air space side of open weep holes with copper or plastic insect screening before placing loose-fill masonry insulation in cavity.

3.9 FLASHING.

3.9.01 General. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.

Prepare masonry surfaces so that they are smooth and free from projections that could puncture flashing. Place through-wall flashing on sloping bed or mortar and cover with mortar. Seal penetrations in flashing with adhesive sealant or tape as recommended by flashing manufacturer before covering with mortar.

At lintels and shelf angles, extend flashing a minimum of 4 inches (10.16 cm) into masonry at each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches (10.16 cm), and through the inner wythe to within ½ inches (1.27 cm) of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches (5.08 cm), unless otherwise indicated.

At head and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches (5.08 cm) to form a pan. Cut off flashing flush with face of wall after masonry wall construction is completed.

Extend flashings horizontally through outer wythe at foundation walls, above ledge or shelf angles and lintels, under parapet caps, and at bottom of walls, and turn down outside face to form a dip. Turn flashing up minimum 8 inches (20.32 cm) and bed into mortar joint of masonry seal to concrete or seal to sheathing over wood or steel stud framed backing. Lap end joints minimum 6 inches (15.24 cm) and seal watertight. Turn flashing, fold, and seal at corners, bends, and interruptions.

Also comply with Master Specification Section 07500, Flashing and Trim.

3.10 LINTELS. Install steel lintels where indicated.

Provide masonry lintels where shown and wherever openings of more than 1’0” (30.48 cm) for brick size units and 2’-0” (60.96 cm) for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout.

Provide minimum bearing of 8 inches (20.32 cm) at each jamb, unless otherwise indicated.

3.11 MOVEMENT (CONTROL AND EXPANSION) JOINTS: Install control and expansion joints in unit masonry where indicated. Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement. Do not continue horizontal joint reinforcement through control and expansion joints.

To form control joints in concrete masonry, fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces. Install preformed control joint gaskets designed to fit standard sash block in continuous lengths. Seal butt and corner joints. Install special shapes designed for control joints. Install bond breaker strips at joint. Keep head joints free and clear of mortar or rake joint.

Build in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod specified in Master Specification Section 07600, Caulking and Sealers. Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.12 CAVITY BEHIND VENEER. Do not permit mortar to drop or accumulate into cavity air space or to plug weeps. Build outer wythe to permit installation of cavity insulation and air/vapor barrier adhesives.

3.13 JOINT REINFORCEMENT AND ANCHORAGE. Install horizontal joint reinforcement 16 inches (40.6 cm) on center. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (40.6 cm) each side of opening. Place joint reinforcement continuous in first and second joint below top of walls. Lap joint reinforcement ends minimum 6 inches (15.2 cm).

Embed wall ties in masonry backing to bond veneer for every 2 - 2/3 sq. ft. (0.25 sq m) on center each way around perimeter of within 12 inches (30.5 cm) of openings. Secure wall ties, rod, strap, anchors, to stud framed backing and embed into masonry veneer at maximum 16 inches (40.6 cm) on center vertically and 36 inches (91.4 cm) on center horizontally. Place a maximum 3 inches (7.6 cm) on center each way around perimeter of openings, within 12 inches (30.5 cm) of openings. Reinforce stack bonded unit, joint corners, and intersections with strap anchors 16 inches (40.6 cm) on center.

3.14 FIELD QUALITY CONTROL.

3.14.01 Brick and Clay Tile Units. Test each type in accordance with ASTM C67 at a rate of 5 random units for each 50,000 units installed.

3.14.02 Concrete Masonry Units. Test each type in accordance with ASTM C140.

3.15 REPARING AND POINTING. Remove excess mortar and mortar smears. Replace defective mortar. Match adjacent work.

Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.

During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.

3.16 CLEANING. Clean soiled surfaces with cleaning solution. Use non-metallic tools in cleaning operations.

3.16.01 Final Cleaning. After mortar is thoroughly set and cured, clean masonry as follows:

> Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

Test cleaning methods on sample wall panel; leave ½ panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.

Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering then with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

Wet wall surface with water prior to application of cleaners; remove cleaners promptly by rising thoroughly with clear water.

Clean brick by means of bucket and brush hand-cleaning methods described in BIA "Technical Note No. 20 Revised" using the following masonry cleaner:

Proprietary acidic cleaner; apply in compliance with directions of acidic cleaner manufacturer.

Provide final protection and maintain wall condition, in a manner acceptable to Installer, ensuring that unit masonry is without damage and deterioration at time of Substantial Completion.

End of Section

SECTION 04820

REINFORCED UNIT MASONRY ASSEMBLIES

PART 1 – GENERAL

1.1 SCOPE. This section includes steel reinforced, structural and load bearing masonry, usually with high slump grout or concrete filled cores, cavities, and horizontal bond beams and lintels.

1.2 GENERAL

1.2.01 Coordination. Conduct preinstallation conference at Project site as required in Contract Documents.

1.2.02 Governing Standards. Comply with the requirements and recommendations set forth in the following publications and standards.

ASTM (American Society for Testing and Materials) A153/A153M – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A183 – Steel Welded Wire Fabric, Plain for Concrete Reinforcement.

ASTM A496 – Steel Wire Deformed, for Concrete Reinforcement.

ASTM A497 – Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.

ASTM A563 – Carbon and Alloy Steel Nuts.

ASTM A580/A580M – Stainless Steel Wire.

ASTM A615/A615M – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM A641 – Zinc-Coated (Galvanized) Carbon Steel Wire.

ASTM A653 – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A666 – Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A775/A775M – Epoxy-Coated Reinforcing Steel Bars.

ASTM A951 – Masonry Joint Reinforcement.

ASTM B370 – Copper Sheet and Strip for Building Construction.

ASTM C34 – Structural Clay Load-Bearing Wall Tile.

ASTM C55 – Concrete Brick.

ASTM C56 – Structural Clay Non-Load-Bearing Tile.

ASTM C62 – Building Brick (Solid Masonry Units Made from Clay or Shale).

ASTM C67 – Test Method for Sampling and Testing Brick and Structural Clay Tile.

ASTM C73 – Calcium Silicate Brick (Sand-Lime Brick).

ASTM C90 – Load-Bearing Concrete Masonry Units.

ASTM C91 – Masonry Cement.

ASTM C126 – Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.

ASTM C129 – Non-Load-Bearing Concrete Masonry Units.

ASTM C140 – Test Methods for Sampling and Testing Concrete Masonry Units and Related Units and Related Units.

ASTM C144 – Aggregate for Masonry Mortar.

ASTM C150 – Portland Cement.

ASTM C207 – Hydrated Prime for Masonry Purposes.

ASTM C212 – Structural Clay Facing Tile.

ASTM C216 – Facing Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C270 – Mortar for Unit Masonry.

ASTM C315 – Clay Flue Linings.

ASTM C404 – Aggregate for Masonry Mortar.

ASTM C476 – Grout for Masonry.

ASTM C516 – Virminiculite Loose Fill Thermal Insulation.

ASTM C530 – Structural Clay Non-Load-Bearing Screen Tile.

ASTM C652 – Hollow Brick (Hollow Masonry Units Made From Clay or Shale).

ASTM C744 – Prefaced Concrete and Calcium Silicate Masonry Units.

ASTM C1261 – Firebox Brick for Residential Fireplaces.

ASTM D226 – Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM E119 – Test Methods for Fire Tests of Building Construction and Materials.

Masonry Standards Joint Committee (MSJC) Code/American Concrete Institute (ACI) 530/American Society of Civil Engineers (ASCE) 5/The Masonry Society (TMS) 402 – Building Code Requirements for Masonry Structures.

MSJC Specification/ACI 530.1/ASCE 6/TMS 602 – Specifications For Masonry Structures.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Contractor shall have a minimum of five years documented experience in the construction of reinforced unit masonry assemblies on projects of this size and type. Contractor shall provide a list of completed projects with project names, addresses, telephone numbers, names of Owners, and other information specified.

1.3.02 Testing Laboratory Qualifications. To qualify for employment in performing tests and inspection specified in this Section, an independent testing laboratory must demonstrate to Engineer’s satisfaction, based on evaluation of submitted criteria conforming to ASTM C1093, that it has the experience and capability to conduct the testing indicated without delaying the progress of the Work.

1.3.03 Fire Performance Characteristics. Where indicated, provide materials and construction identical to those of assemblies whose fire resistance has been determined per ASTM E119 by a testing and inspection organization, by equivalent concrete masonry thickness, or by another means acceptable to authorities having jurisdiction.

1.3.04 Single-Source Responsibility for Masonry Units. Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.

1.3.05 Single-Source Responsibility for Mortar Materials. Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitous component and from one source and producer for each aggregate.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Shop drawings for reinforcing detailing fabrication, bending, and placement of unit masonry reinforcing bars. Comply with ACI 315 “Details and Detailing of Concrete Reinforcing” showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of masonry reinforcement.

Submit product data for each different masonry unit, accessory, and other manufactured product indicated.
Submit cold and hot-weather construction procedures indicating compliance with requirements specified in referenced unit masonry standard.

1.4.02 Certifications. Submit material certificates signed by manufacturer and Contractor certifying that each material complies with requirements for the following:

Each different cement product required for mortar and grout including name of manufacturer, brand, type, and weight slips at time of delivery.

Each material and grade indicated for reinforcing bars.

Each type and size of joint reinforcement.

Each type and size of anchors, ties, and metal accessories.

1.4.03 Samples. Submit four samples of full-size units for each different exposed masonry unit required showing full range of exposed color, texture, and dimensions to be expected in completed construction. Include size variation data verifying that actual range of sizes for brick falls within ASTM C216 dimension tolerances for brick where modular dimensioning is indicated.

Submit four samples of colored masonry mortar samples for each color required showing the full range of colors expected in the finished construction. Label samples to indicate type and amount of colorant used.

1.4.04 Test Reports. Submit material test reports from a qualified independent testing laboratory employed and paid by Contractor showing that mortar complies with property requirements of ASTM C270.

1.4.05 Mock-Ups. Prior to installation of unit masonry, erect sample wall panels to further verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution. Build mock-ups at location determined by Engineer.

Build mock-ups for each type of exposed reinforced masonry wall and typical exterior face brick wall in sizes of approximately 9 feet long by 6 feet (2.74 by 1.83 meters) high by full thickness, including face and backup wythes as well as accessories.

Notify Engineer one week in advance of the dates and times when mock-ups will be erected, and protect mock-ups from the elements with weather-resistant membrane.

Retain and maintain mock-ups during construction in undisturbed condition as standard for judging completed unit masonry construction.

When directed, demolish and remove mock-ups from Project site. Accepted mock-ups in undisturbed condition at time of Substantial Completion may become part of completed unit of work.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver masonry materials to project site in undamaged condition.

Store and handle masonry units off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.

Store cementitious materials off the ground, under cover, in dry location, and aggregates where grading and other required characteristics can be maintained and contamination avoided.

Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS.

2.1.01 Protection of Masonry. During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches (60.96 cm) down both sides and hold cover securely in place.

Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (60.96 cm) down face next to unconstructed wythe and hold cover in place.

Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

2.1.02 Stain Prevention. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that come in contact with such masonry.

Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

Protect sills, ledges, projection, surfaces of window and door frames, as well as similar products with painted and integral finishes from mortar droppings.

2.1.03 Cold-Weather Construction. Comply with unit masonry standards for cold-weather construction. Do not lay masonry units that are wet or frozen. Remove masonry, which is damaged by freezing conditions.

2.1.04 Hot-Weather Construction. Comply with unit masonry standards for hot weather construction.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.2.01 Allowable Working Stresses in Reinforced Masonry.

Type of Stress	*Type of Unit*	*Hollow Clay Units[1] Grade LB or Hollow Concrete Units Grade A*		*Grouted Solid, Hollow Units: Concrete, Grade A Clay, Grade LB or Solid Units 2500 psi on Gross*		*Solid Units 3000 psi on Gross*	
Ultimate compressive strength	*f'm*	675	1350	750	1500	900	1800
Compressive – Axial, walls	*0.2 f'm*	135	270	150	300	180	360
Compressive – Axial, columns	*.18 f'm*	122	244	135	270	162	324
Compression-Flexural	*.33 f'm*	225	450	250	500	300	600

Shear							
No shear reinforcement[2]	*.02 f'm*	15	27	15	30	15	36
Reinforcement taking entire shear;							
Flexural members	*.05 f'm*	50	67	50	75	50	90
Shear walls	*.04 f'm*	30	54	30	60	30	72
No shear reinforcement,							
Flexural2	$1.1\sqrt{f'm}$	25	40	25	43	25	47
Shear walls							
M/Vd ≥ 1	$.9\sqrt{f'm}$	17	33	17	34	17	34
M/Vd = 0	$2.0\sqrt{f'm}$	25	50	25	50	25	50
Reinforcing taking all shear,							
Flexural	$3.0\sqrt{f'm}$	75	110	75	116	75	127
Shear walls							
M/Vd ≥ 1	$1.5\sqrt{f'm}$	35	55	35	58	35	64
M/Vd = 0	$2.0\sqrt{f'm}$	52	73	55	77	60	85

[1]Stresses for hollow unit masonry are based on net section.
[2]Web reinforcement shall be provided to carry the entire shear in excess of 20 psi whenever there is required negative reinforcement and for a distance of one-sixteenth the clear span beyond the point of infection.

2.3 MATERIALS. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.

2.3.01 Clay Masonry Units. Provide special molded shapes for applications requiring brick of form, color, texture, and size on exposed surfaces that cannot be produced by sawing standard brick sizes as well as where stretcher units cannot accommodate special conditions including those at corners, movement joints, bond beams, sashes, and lintels.

Provide units without cores and with all exposed surfaces finished for ends of sills, caps, and similar applications that expose brick surfaces that otherwise would be concealed from view.

Hollow brick shall be ASTM C652, Grade SW, Type HBX (for general use in exposed masonry requiring minimum variations in size and color ranges) with minimum average net area compressive strength of 3000 psi (210.92 kg/cm^2).

Provide bricks manufactured to the following actual dimensions within the tolerances specified in ASTM C652 as 3 5/8 inches thick by 3 5/8 inches (9.21 by 9.21 cm) high by 11 5/8 inches (29.53 cm) long with a single score.

2.3.02 Concrete Masonry Units. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions, bullnose units for outside corners unless otherwise indicated. Utilize square-edged units for outside corners, except where indicated as bullnose.

Concrete masonry units shall be Type I, moisture-controlled units manufactured to specified dimensions of 3/8 inch (9.5 mm) less than nominal widths by nominal heights by nominal lengths indicated on drawings.

Where special patterns are indicated, provide units with exposed faces matching color, texture and pattern of Engineer's sample.

Hollow load-bearing concrete masonry units shall be ASTM C90, Grade N. Provide units with minimum average net area compressive strength of 1900 psi (133.59 kg/cm^2) with light weight classification.

Splitface Concrete Block lightweight concrete units shall have exposed aggregate and exposed weathering face complying with ASTM C90.

Subject to compliance with requirements, provide "Rickstone" by United Glazed Products, "Preier Line" by E. Dillion & Co., Splitface by Grand Blanc Cement Products, Inc., or an approved equal.

2.3.03 Mortar and Grout Materials. Portland Cement shall be ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce required mortar color.

Masonry Cement shall be ASTM C91. For colored pigmented mortars use premixed colored masonry cements of formulation required to produce color indicated or if not indicated as selected from manufacturer's standard formulations.

Ready-Mixed Mortar shall be comprised of cementitious materials, water, and aggregate complying with requirements specified in this article, combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C1142.

Hydrated Lime shall be ASTM C207, Type S for hydrated lime.

Aggregate for mortar shall meet ASTM C144, except for joints less than 1/4 inch (6.4 mm) use aggregate graded with 100 percent passing the No. 16 sieve.

Aggregate in grout shall meet ASTM C404.

Colored mortar pigments shall be natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars. Subject to compliance with requirements, provide “Centurion Pigments” by Centurion; “True Tone Mortar Colors” by Davis Colors, A Subsidiary of Rockwood Industries, Inc.; “SGS Mortar Colors” by Solomon Grind-Chem Services, Inc.; or an approved equal.

Water shall be clean and potable.

2.3.04 Reinforcing Steel. Provide reinforcing steel complying with requirements of referenced unit masonry standards and this article.

Steel reinforcing bar material and grade shall be epoxy-coated billet steel complying with ASTM A615 and ASTM A775, Grade 60.

Deformed reinforcing wire shall be per ASTM A496. Plain welded wire fabric shall be per ASTM A185. Deformed welded wire fabric shall be per ASTM A497.

2.3.05 Joint Reinforcement. Provide joint reinforcement complying with requirements of referenced unit masonry standard and this article, formed from stainless steel wire, Type 304 complying with ASTM A580.

Welded-wire units shall be prefabricated with deformed continuous side rods and plain cross rods into straight lengths of not less than 10 feet (3.05 m), with prefabricated corner and tee units, and complying with requirements indicated below:

Wire Diameter for Side Rods: 0.1875 inch (4.8 mm).

Wire Diameter for Cross Rods: 0.1875 inch (4.8 mm).

For single-wythe masonry, provide truss design with continuous diagonal cross rods spaced not more than 16 inches (40.6 cm) o.c. type as follows with single pair of side rods.

The number of side rods for multiwythe concrete masonry shall be one side rod for each face shell of hollow masonry units more than 4 inches (10.2 cm) in nominal width plus one side rod for each wythe of masonry 4 inches (10.2 cm) or less in nominal width.

Tab design with single pair of side rods and rectangular box-type cross ties spaced not more than 16 inches (40.6 cm) o.c.; with side rods spaced for embedment within each face shell of backup wythe and ties extended to engage the outer wythe by at least 1 1/2 inches (3.8 cm).

Subject to compliance with requirements, provide joint reinforcement by AA Wire Products Co., Dur-O-Wal, Inc., Heckman Building Products, Inc., or an approved equal.

2.3.06 Rigid Anchors. Provide straps of form and length indicated, fabricated from metal strips of 1 1/2 inches (3.8 cm) wide by 1/4 inch (6.4 mm) thick.

2.3.07 Anchor Bolts. Steel bolts shall comply with A307, Grade A; hex nuts shall comply with ASTM A563 and flat washers shall be provided where indicated, hot-dip galvanized to comply with ASTM A153, Class C. All items shall be of diameter and length indicated and nonheaded bolts shall be bent in manner indicated.

2.3.08 Laminated Flashing. Manufacturer’s standard laminated flashing shall be of Copper-Fabric Laminate. Copper sheet of 5 oz weight per square foot (1526 grams per square meter), bonded with asphalt between 2 layers of glass fiber cloth. Apply where flashing is fully concealed in masonry.

Subject to compliance with requirements, provide Copper Fabric” by Afco Products Inc.;“Type FCC-Fabric Covered Copper” by Phoenix Building Products.; “Copper Fabric Flashing” by Sandell Manufacturing Co., Inc.; “York Copper Fabric Flashing” by York Manufacturing, Inc.; or an approved equal.

Use adhesive of type recommended by flashing manufacturer for use indicated.

2.3.09 Bond Breaker Strips. Asphalt-saturated organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).

2.3.10 Weep Holes. Provide Vinyl Weep Hole/Vent as one-piece offset T-shaped units formed to fit in a vertical mortar joint by injection molding of flexible polyvinyl chloride and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units and top flap; in color approved by Engineer to match that of mortar. Subject to compliance with requirements, provide weep hole/ventilators products by “Williams-Goodco Brick Bent”, Williams Products, Inc. or approved equal.

2.3.11 Insulation. Loose Granular Vermiculite Insulation shall be per ASTM C516, Type II (surface-treated for water repellency and limited moisture absorption), Grade 3 (fine), complying with 29 CFR 1926 by containing less than 0.10 percent by weight of asbestos and that demonstration shows will not release asbestos fibers in excess of 0.1 fibers per cubic centimeter under reasonably foreseeable jobsite conditions.

2.3.12 Proprietary Acidic Cleaner. Manufacturer’s standard-strength, general-purpose cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry surfaces of type indicated below without discoloring or damaging masonry surfaces; expressly approved for intended use by manufacturer of masonry units being cleaned:

For masonry not subject to metallic oxidation stains, use formulation consisting of a concentrated blend of surface-acting acids, chelating, and wetting agents.

Subject to compliance with requirements, provide by “Sure Klean Vana Trol”, ProSoCo, or approved equal.

2.3.13 Mortar and Grout Mixes. Do not add admixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated, and do not use calcium chloride in mortar or grout.

2.3.14 Mortar for Unit Masonry. Comply with ASTM C270, property specification for job-mixed mortar and ASTM C1142 for ready-mixed mortar. Limit cementitious materials in mortar to Portland cement-lime.

For exterior, reinforced masonry, above-grade load-bearing and non-load-bearing walls and parapet walls; for interior loadbearing walls; for interior non-load-bearing and non-load-bearing partitions, reinforced masonry and for other applications where another type is not indicated use type N.

2.3.15 Colored Pigmented Mortar. Select and proportion pigments with other ingredients to produce color required. Mix to match Engineer’s sample.

2.3.16 Grout for Unit Masonry. Comply with ASTM C476 and referenced unit masonry standard.

PART 3 – EXECUTION

3.1 INSPECTION. Examine conditions, with installer present, for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry. Prepare written report, endorsed by Contractor, listing conditions detrimental to performance of unit masonry.

Examine rough-in and built-in construction to verify actual locations of piping connections prior to installation. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION. Comply with MSJC Code, specifications, and other requirements indicated as applicable to each type of assembly included in Project.

3.2.01 Thickness. Build cavity and composite walls and other masonry construction to the full thickness shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

Build chases and recesses as shown or required to accommodate items specified in this and other Master Specification Sections. Provide not less than 8 inches (20.32 cm) of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.

Leave openings for equipment to be installed before completion of masonry. After installation of equipment, complete masonry to match construction immediately adjacent to the opening.

Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

3.2.02 Placement. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint widths and for accurate locating of openings, movement-type joints, returns, and offsets. Avoid the use of less-than-half-size units at corners, jambs, and where possible at other locations.

Lay up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

3.2.03 Bond Pattern for Exposed Masonry. Lay exposed masonry in a bond pattern of one half running bond with vertical joint in each course centered on units in courses above and below for brick with triple score and concrete masonry units and one quarter running bond for brick with single score. Do not use units with less than nominal 4 inch (10.16 cm) horizontal face dimensions at corners or jambs.

Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches (5.08 cm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (10.16 cm) horizontal face dimensions at corners of jambs.

3.2.04 Stopping and Resuming Work. In each course, rack back 1/2-unit length for one-half running bond or 1/3-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly (if required), and remove loose masonry units and mortar prior to laying fresh masonry.

3.2.05 Built-In Work. As construction progresses, build in items specified under this and other Master Specification Sections. Fill in solidly with masonry around built-in items. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

At exterior frames insert extruded polystyrene board insulation around perimeter of frame in thickness indicated but not less than 3/4 inch (1.91 cm) to act as a thermal break between frame and masonry.

Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core. Fill cores in hollow concrete masonry units with grout 3 courses (24 inches (60.96 cm)) under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.2.06 Mortar Bedding and Jointing. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells. Provide bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.

For starting course on footings where cells are not grouted, spread out full mortar bed including areas under cells.

Cut joints flush for masonry walls to be concealed or to be covered by other materials, unless otherwise indicated.

3.2.07 Structural Bonding of Multiwythe Masonry. Use individual metal ties installed in horizontal joints to bond wythes together.

Use continuous horizontal joint reinforcement installed in horizontal mortar joints for bond tie between wythes.

Use structural bonding system specified above and as indicated on Drawings.

Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.

Provide continuity with horizontal joint reinforcement at corners using prefabricated “L” units, in addition to masonry bonding.

For intersecting and abutting walls, unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and space using individual metal ties and prefabricated “T” units to provide continuity with horizontal joint reinforcement.

For non-bearing interior partitions, build full height of story to underside of solid floor or roof structure above. Install pressure-relieving joint filler in joint between top of partition and underside of structure above. Wedge non-bearing partitions against structure above with small pieces of tile, slate, or metal.

3.2.08 Cavity Wall and Masonry-Cell Insulation. Pour granular insulation into cavities as shown to fill void spaces completely. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close ports after complete coverage has been confirmed. Limit fall of insulation to one story in height, but not to exceed 20 feet (6.10 m).

3.2.09 Horizontal Joint Reinforcement. Provide continuous horizontal joint reinforcement as indicated. Install longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch (1.59 cm) on exterior side of walls and 1/2 inch (1.27 cm) elsewhere. Lap reinforcing a minimum of 6 inches (15.24 cm). Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

Provide continuity at corners and wall intersections by use of prefabricated “L” and “T” sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.2.10 Movement (Control and Expansion) Joints. Install control and expansion joints in unit masonry where indicated. Build in related items as the masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

Fit bond breaker strips into hollow contour in ends of block units on one side of control joint. Fill the resultant core with grout and rake joints in exposed faces. Install preformed control joint gaskets designed to fit standard sash block. Install special shapes designed for control joints. Install bond breaker strips at joint. Keep head joints free and clear of mortar or rake joint.

Build in horizontal pressure-relieving joints where indicated; construct joints by either leaving an air space or inserting nonmetallic 50 percent compressible joint filler of width required to permit installation of sealant and backer rod specified in Master Specification Section 07600, Caulking and Sealers.

Locate horizontal pressure-relieving joints beneath shelf angles supporting masonry veneer and attached to structure behind masonry veneer.

3.2.11 Lintels. Install steel lintels where indicated.

Provide masonry lintels where shown and wherever openings of more than 1 foot (30.48 cm) for brick size units and 2 feet (60.96 cm) for block size units are shown without structural steel or other supporting lintels. Provide precast or formed-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.
For hollow concrete masonry unit walls, use specially formed bond beam units with reinforcement bars placed as indicated and filled with coarse grout.

Provide minimum bearing of 8 inches (20.32 cm) at each jamb, unless otherwise indicated.

3.2.12 Flashing/Weep Holes. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.

Prepare masonry surfaces so that they are smooth and free form projections that could puncture flashing. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing with adhesive/sealant/tape as recommended by flashing manufacturer before covering with the mortar.

Install flashings as follows at lintels and shelf angles, extending flashing a minimum of 4 inches (10.16 cm) into masonry at each end. Extend flashing from exterior face of outer wythe of masonry, through the outer wythe, turned up a minimum of 4 inches (10.16 cm), and through the inner wythe to within 1/2 inch (1.27 cm) of the interior face of the wall in exposed masonry. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches (5.08 cm), unless otherwise indicated. At heads and sills, extend flashing as specified above unless otherwise indicated but turn up ends not less than 2 inches (5.08 cm) to form a pan.

Cut off flashing flush with face of wall after masonry wall construction is completed.

Install weep holes in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing. In air spaces insulated cavities, cover the cavity/air space side of open weep holes with copper or plastic insect screening before placing loose-fill masonry insulation in cavity.

3.2.13 Reinforced Unit Masonry. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.

Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

3.2.14 Repairs. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or if units do not match adjoining units. Install new units to match adjoining units and in fresh mortar or grout, pointed to eliminate evidence of replacement.

3.2.15 Pointing. During the tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up all joints including corners, openings, and adjacent construction to provide a neat, uniform appearance, prepared for application of sealants.

3.2.16 Final Cleaning. After mortar is thoroughly set and cured, clean exposed masonry.

Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

Test cleaning methods on sample wall panel; leave 1/2 panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.

Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.

Clean brick by means of bucket and brush hand-cleaning method described in BIA "Technical Note No. 20 Revised" using proprietary acidic cleaner and apply in compliance with directions of acidic cleaner manufacturer.

3.2.17 Protection. Provide final protection and maintain conditions, in a manner acceptable to Engineer, that ensures unit masonry is without damage and deterioration at time of Substantial Completion.

End of Section

SECTION 04900

MASONRY RESTORATION AND CLEANING

PART 1 – GENERAL

1.1 SCOPE. This section includes restoration of masonry surfaces of brick, stone, clay tile, terra cotta, and block by water, steam, sand blasting, or chemical cleaning. Sand blast cleaning of masonry is not recommended except in special circumstances. Replacement of masonry units and repointing of joints are also included.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publication and addenda thereto of the following standards:

> ASTM (American Society for Testing and Materials) C91 – Masonry Cement.
>
> ASTM C144 – Aggregate for Masonry Mortar.
>
> ASTM C150 – Portland Cement.
>
> ASTM C270 – Mortar for Unit Masonry.
>
> Masonry Standards Joint Committee (MSJC) Code/American Concrete Institute (ACI) 530/American Society of Civil Engineers (ASCE) 5/The Masonry Society (TMS) 402 – Building Code Requirements for Masonry Structures.
>
> MSJC Specification/ACI 530.1/ASCE 6/TMS 602 – Specifications For Masonry Structures.

Submit installation procedures for the products selected for use, manufacturer's installation instructions, and perimeter conditions requiring special attention.

1.3 QUALITY ASSURANCE. Perform work in accordance with local Code and MSJC Specification.

1.3.01 Manufacturer Qualifications. Company specializing in manufacturing products specified in this section with minimum five years documented experience.

1.3.02 Contractor's Qualifications. Work of this section must be performed by firms specializing in restoration with having not less than 5 years successful documented experience in comparable masonry restoration projects and employing personnel skilled in the restoration processes and operations indicated.

1.3.03 Cleaning. Demonstrate materials and methods to be used for cleaning each type of masonry surface and condition where directed. Test adjacent non-masonry materials for possible reaction with cleaning materials. Allow waiting period of duration recommended by manufacturer, but not less than 7 calendar days, after completion of sample cleaning to permit study of sample panels for negative reactions.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings detailing all shoring, bracing and temporary or permanent supports. Indicate setting details of cut stone, special brick shapes and special supports for the work.

Submit data on cleaning compounds and cleaning solutions.

1.4.02 Samples. Submit four samples of concrete masonry units, face brick, stone, terra cotta, or clay tile; units to illustrate color, texture and extremes of color range to match existing.

1.4.03 Mock-up. Restore and repoint a masonry wall sized 8 feet (2.44 m) long by 6 feet (1.83 m) high, which includes mortar and accessories, wall openings and flashings.

Clean a 10 x 10 foot (3.05 x 3.05 m) panel of wall to determine extent of cleaning, cleaning methods and cleaning products.

Repeat, using different cleaning methods on up to three different panels, until acceptable.

Acceptable panel and method of procedure will become the standard for work of this section.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver masonry and stone neatly stacked and tied on pallets. Store clear of ground with adequate waterproof covering.

Store sand blasting, acid solution and restoration cleaner materials in manufacturer's packaging.

Store mortar ingredients in manufacturer's packaging, or if delivered loose, with adequate weatherproof covering.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Clean masonry surfaces only when air temperatures are 40 degrees F (4.4 degrees C) and above and will remain so until masonry has dried out, but for not less than 7 days after completion of cleaning.
Do not repoint mortar joints unless air temperatures are between 40 degrees F (4.4 degrees C) and 80 degrees F (26.7 degrees C) and will remain so for at least 48 hours after completion of work.

Prevent grout or mortar used in repointing and repair work from staining face of surrounding masonry and other surfaces. Remove immediately grout and mortar in contact with exposed masonry and other surfaces.

Protect sills, ledges and projections from mortar droppings.

2.2 MATERIALS.

2.2.01 Mortar. Portland Cement shall be ASTM C150, Type 1. For masonry, provide non-staining natural or white cement (as required to produce mortar color selected), complying with staining requirement of ASTM C91 for not more than 0.03% water soluble alkali.

Hydrated Lime shall be ASTM C207, Type S.

Aggregate shall be ASTM C144, unless otherwise indicated. Natural or manufactured sand selected to produce mortar color selected. For pointing mortar provide sand with rounded edges. Match size, texture and gradation of existing mortar as closely as possible.

Water shall be clean, free of oils, acids, alkalis and organic matter.

2.2.02 Cleaning Materials And Equipment. Water for Cleaning shall be clean, potable, free of oils, acids, alkalis, salts, and organic matter.

Brushes shall be fiber bristle only.

Use a standard two-part masonry cleaner consisting of alkaline cleaner for prewash and acidic cleaner for afterwash. Acceptable products include "Sure Klean Limestone Prewash and Afterwash" as manufactured by ProSoCo, Inc. or approved equal.

Provide spray equipment for controlled spray application of water and chemical cleaners, if any, at rates indicated for pressure and volume as measured at spray tip.

For spray application of chemical cleaners, provide low-pressure tank or chemical pump suitable for chemical cleaner indicated, equipped with cone-shaped spray-tip. For spray application, of water provide fan-shaped spray-tip which disperses water at an angle of not less than 15 degrees.

For application of steam, provide a steam generator capable for delivering live steam at nozzle head.

2.2.03 Mortar Mixes. Measure cementitious and aggregate material in a dry condition by volume or equivalent weight. Do not measure by shovel, use known measure. Mix materials in a clean mechanical batch mixer.

Thoroughly mix cementitious and aggregate materials together before adding any water. Then mix again adding only enough water to produce a damp, unworkable mix which will retain its form when pressed into a ball. Maintain mortar in this dampened condition for 1 to 2 hours. Add remaining water in small portions until mortar of desired consistency is reached. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.

Do not use admixtures of any kind in mortar, unless otherwise indicated.

For pointing mortar use one part white Portland cement, 2 parts lime and 6 parts colored mortar aggregate.

For rebuilding mortar use ASTM C270, Proportion Specification, Type N, unless otherwise indicated with cementitious material content limited to Portland cement-lime.

2.2.04 Chemical Cleaning Solutions. Unless otherwise indicated, dilute chemical cleaning materials such as alkaline and acid cleaner with water to produce solutions of concentration not greater than that recommended by chemical cleaner manufacturer.

PART 3 – EXECUTION

3.1 PREPARATION. Comply with recommendations of manufacturers of chemical cleaners for protecting building surfaces against damage from exposure to their products.

Protect persons, motor vehicles, surrounding surfaces of building whose masonry surfaces are being restored, building site, and surrounding buildings from injury resulting from masonry restoration work.

Prevent chemical cleaning solutions from coming into contact with pedestrians, motor vehicles, landscaping, building and other surfaces which could be injured by such contact.

Do not clean masonry during winds of sufficient force to spread cleaning solutions to unprotected surfaces.

Protect glass, unpainted metal trim and polished stone from contact with chemical cleaners by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape. Apply masking agent to comply with manufacturer's recommendations. Do not apply liquid masking agent to paint or porous surfaces. Protection can be eliminated subject to Engineer's approval, if testing demonstrates no detrimental effect from exposure to cleaning solutions.

3.2 PERFORMANCE.

3.2.01 Sequencing/Scheduling. Perform masonry restoration work in the following sequence when items listed occur in the same location:

Rake-out existing mortar from joints to be repointed.

Repoint existing mortar joints as required.

Clean existing masonry surfaces.

Install joint sealers.

Coordinate with the Engineer sequencing, scheduling, and notification procedures relating to removals of masonry to expose concealed conditions for inspection and observation.

3.2.02 Cleaning Existing Masonry. Proceed with cleaning in orderly manner; work from top to bottom of each scaffold width and from one end of each elevation to the other.

Use only those cleaning methods indicated for each masonry material and location.

Perform each cleaning method indicated in a manner which results in uniform coverage of all surfaces, including corners, moldings, interstices and which produces an even effect without streaking or damage to masonry surfaces.

Rinse off chemical residue and soil by working upwards from bottom to top of each treated area at each stage or scaffold settings.

Water Application Methods: For prolonged spraying soak masonry surfaces by applying water continuously and uniformly to limited area for time period indicated. Apply water at low pressures and low volumes in form of multiple fine sprays using perforated hoses or multiple spray nozzles. Erect protective enclosure constructed of polyethylene sheeting to cover area being sprayed.

For other spray applications spray water onto masonry surfaces to comply with requirements indicated for location, purpose, water temperature, pressure, volume and equipment. Unless otherwise indicated, hold spray nozzle not less than 6 inches (15.24 cm) from surface of masonry and apply water from side to side in overlapping bands to produce uniform coverage and an even effect using the appropriate pressure and volume below.

> Low Pressure Spray: 100-400 psi (689.48 – 2757.42 kPa); 3-6 gallons (11.36 – 22.71 liters) per minute.
>
> Medium Pressure Spray: 400-800 psi (2757.92 – 5515.84 kPa); 3-6 gallons (11.36 – 22.71 liters) per minute.
>
> High Pressure Spray: 800-1200 psi (5515.84 – 8273.76 kPa); 3 gallons (11.36 liters) per minute.

To steam wash apply steam to masonry surfaces at pressure not exceeding 80 psi. Hold nozzle not less than 6 inches (15.24 cm) from surfaces of masonry and apply steam from side to side or in direction of tooling in overlapping bands to produce uniform coverage and an even effect.

Apply chemical cleaners to masonry surfaces to comply with chemical manufacturer's recommendations using brush or spray application methods. Do not allow chemicals to remain on surface for periods longer than that indicated or recommend by manufacturer.

Apply to pressures not exceeding 50 psi (344.74 kPa), unless otherwise indicated.

Do not apply chemical cleaners to same masonry surfaces more than twice. If additional cleaning is required use steam wash.

3.2.03 Cleaning Brickwork. At all brick masonry to receive surface grouting or clear sealer, clean brick masonry surface with cold water applied with low pressure spray.

3.2.04 Cleaning Stonework. At all stone masonry to receive clear sealer, clean stone surfaces with cold water applied with low-pressure spray.

Where indicated, clean limestone surfaces with two-part systems using cleaners of dilution indicated, applied as follows:

Pre-set stone with cold water applied by low-pressure spray.

Apply alkaline cleaner for prewash to stone by bush or roller. Let cleaner remain on surface for period recommended by cleaner manufacturer or as determined by preliminary testing.

Rinse stone with cold water to remove chemical and oils, applied by medium pressure spray.

Apply acidic cleaner for afterwash to stone while it is still wet using low-pressure spray equipment or deep nap roller or soft fibered brush. Let cleaner remain on surface for period recommend by cleaner manufacturer or as determined by preliminary testing.

Rinse stone with cold water to remove chemicals and soil, applied by medium pressure spray.

Repeat entire cleaning procedure above where required to produce cleaning effect established by testing. Do not apply more than twice.

3.2.05 Repointing Existing Masonry.

Joint Raking: Rake out mortar from joints to depths equal to 2 1/2 times their widths but not less than 1/2 inch (1.27 cm) nor less than that required to expose sound, unweathered mortar.

Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum or brush joints to remove direct and loose debris.

Do not spall edges of masonry units or widen joints. Replace any masonry units which become damaged.

Cut out old mortar by hand with chisel and mallet, unless otherwise indicated.

Power operated rotary hand saws and grinders will be permitted but only on specific written approval of the Engineer based on submission of a satisfactory quality control program and demonstrated ability of operators to use tools without damage to masonry. Quality control program shall include provisions for supervising performance and preventing damage due to worker fatigue.

Joint Pointing: Rinse masonry joint surfaces with water to remove any dust and mortar particles. Time application of rinsing so that, at time of pointing, excess water has evaporated or run-off, and joint surfaces are damp but free of standing water.

Apply first layer of pointing mortar to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch (9.5 mm) until a uniform depth is formed. Compact each layer thoroughly and allow to become thumbprint-hard before applying next layer.

After joints have been filled to a uniform depth, place remaining pointing mortar in 3 layers with each of first and second layers filling approximately 2/5 of joint depth and third layer the remaining 1/5. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry has rounded edge, recess final layer slightly from face. Take care not to spread mortar over edges onto exposed masonry surfaces, or to featheredge mortar.

When mortar is thumbprint hard, tool joints to match original appearance of joints, unless otherwise indicated. Remove excess mortar from edge of joint by brushing.

At horizontal joints above ledges, setbacks, sills, and at copings, rake out mortar to receive sealant.

Take precautions to avoid plugging weep holes, newly drilled or otherwise.

Cure mortar by maintaining in a damp condition for not less than 72 hours.

Where repointing work precedes cleaning of existing masonry allow mortar to harden not less than 30 days before beginning cleaning work.

3.2.06 Final Cleaning. Perform final cleaning of repaired and repainted stonework in addition to any other cleaning operations scheduled or indicated.

After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter using stiff nylon or bristle bushes and clean water wash.

Use of metal scrapers or brushes will not be permitted.

Use of acid or alkali cleaning agents for final cleaning purposes will not be permitted. Use only at specific locations for stain removal as indicated.

End of Section

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DIVISION 5 – METALS

PAGE NO.

SECTION 05120

STRUCTURAL STEEL

PART 1 – GENERAL

1.1 SCOPE. This section includes fabrication and erection of structural steel. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings.

Steel joists, metal decks, grating and handrails are specified elsewhere.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

AISC Steel Construction Manual

AISC (American Institute of Steel Construction) – Specification for Structural Steel Buildings, Allowable Stress Design (ASD).

AISC - Code of Standard Practice for Structural Steel Buildings and Bridges.

AISC - Seismic Provisions for Structural Steel Buildings.

ASTM (American Society of Testing Materials) A6/A6M – Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.

ASTM A27/A27M - Specification for Steel Castings, Carbon, for General Application.

ASTM A36/A36M – Specification for Carbon Structural Steel.

ASTM A48 – Specification for Gray Iron Castings.

ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

ASTM A108 - Specification for Steel Bars, Carbon Cold-Finished, Standard Quality.

ASTM A123/A123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A143 – Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.

ASTM A153/A153M - Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

ASTM A240/A240M – Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

ASTM A242/A242M - Specification for High-Strength, Low-Alloy Structural Steel.

ASTM A307 - Specification for Carbon Steel Bolts and Studs, 60 ksi Tensile Strength.

ASTM A325 – Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.

ASTM A366/A366M – Specification for Commercial Steel Sheet, Carbon, Cold-Rolled.

ASTM A434 – Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered.

ASTM A449 – Specification for Quenched and Tempered Steel Bolts and Studs.

ASTM A490 - Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.

ASTM A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A501 - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

ASTM A514/A514M - Specification for High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.

ASTM A529/A529M - Specification for High-Strength Carbon-Manganese Steel of Structural Quality.

ASTM A563 – Specification for Carbon and Alloy Steel Nuts.

ASTM A568/A568M - Specification for Steel, Sheet, Carbon and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

ASTM A572/A572 – Specification for High-Strength, Low-Alloy Columbium-Vanadium Structural Steel.

ASTM A700 – Practice for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.

ASTM A780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

ASTM A992/992M – Standard Specifications for Structural Steel Shapes.

ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B211 – Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.

ASTM B308/B308M – Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

ASTM B429 – Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

ASTM C1107 – Specification for Packaged Dry, Hydraulic-Cement Grout (nonshrink).

ASTM E94 – Guide for Radiographic Testing.

ASTM E164 – Practice for Ultrasonic Contact Examination of Weldments.

ASTM E165 – Test Method for Liquid Penetrant Examination.

ASTM E709 – Guide for Magnetic Particle Examination.

ASTM F436 – Specification for Hardened Steel Washers.

ASTM F593 – Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

ASTM F594 – Specification for Stainless Steel Nuts.

ASTM F844 – Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

ASTM F959 – Specification for Compressible-Washer Type Direct Tension Indicators for Use with Structural Fasteners.

AWS (American Welding Society) A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

AWS D1.1 - Structural Welding Code – Steel.

RCSC (Research Council on Structural Connections) (RCSC) – Specification for Structural Joints Using ASTM A325 or A490 Bolts, ASD.

SSPC (Steel Structures Painting Council (SSPC) – Steel Structures Painting Manual, Volumes 1 and 2.

1.3 QUALITY ASSURANCE.

1.3.01 Codes and Standards. Comply with provisions of the following, except as otherwise indicated:

AISC “Code of Standard Practice for Steel Buildings and Bridges,” Paragraph 4.2.1 is hereby modified by deletion of the following sentence:

“This approval constitutes the owner’s acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as a part of his preparation of these shop drawings.”

AISC - “Specifications for Structural Steel Buildings,” including “Commentary.”

ASTM A325 or A490 - “Specifications for Structural Joints using Bolts” approved by the Research Council on Structural Connections.

AWS D1.1 - “Structural Welding Code – Steel.”

ASTM A6 – “Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.”

ASTM 123 - “Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.”

1.3.02 Welding Qualifications. Refer to Master Specification Section 05500, Metal Fabrications, for welding requirements. Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests. If verification of welders is required, retesting will be Contractor’s responsibility.

1.3.03 Plant Certification. All fabricating plants providing structural steel under these specifications shall be certified in accordance with the AISC Quality Certification Program. Fabricating plants shall be certified in accordance with Category I, Conventional Steel Structures.

All shop drawings shall be prepared by or under the direct control of a Category I quality certified plant.

1.3.04 Testing. At contractor’s expense, an independent testing agency acceptable to the Engineer shall perform specified tests and other services required for quality assurance.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete product data, manufacturer’s specifications, installation instructions, detailed drawings, and setting or erection drawings covering all structural and miscellaneous metal items.

Submit complete Shop Drawings complying with the requirements of the current AISC specifications, showing complete information for fabrication and erection of component parts of the structure, including location, type of bolts, size of bolts and welds. Be fully responsible for preparation of Shop Drawings, clearly indicate revisions made on erection drawings and pieces of any resubmittal.

Prepare erection drawings, complete with all necessary plans, elevations and sections, to indicate size and relative position of members. Do not reproduce design drawings for use as erection drawings. Include erection drawings with each submittal indicating marks of all members, assemblies and loose pieces included in the submittal. Indicate on details of all pieces, principal column lines where members are located. Provide setting drawings and direction for installation of anchor rods (bolts) and other anchorage to be embedded in concrete.

Submittals for high strength bolts and load indicator washers shall include statements from the bolt manufacturer certifying satisfactory compliance with the governing standards and the specified tests.

Submit product data or manufacturer’s specifications and installation instructions for products.

High-Strength bolts (each type), including nuts and washers.

Submit shop drawings prepared under supervision of a licensed Structural Engineer, including complete details, schedules for fabrication and assembly of structural steel members, procedures and diagrams.

Include details of cuts, connections, camber, holes and other pertinent data. Indicate welds by standard AWS symbols while showing size, length and type of each weld.

Provide setting drawings, templates and directions for installation of anchor bolts and other anchorages to be installed as work of other sections.

1.4.02 Certifications. Submit certified copies of mill reports for structural steel (each type) covering chemical and physical properties.

1.4.03 Test Reports. Submit laboratory test reports and other data to show compliance with specifications (including specified standards).

Submit test reports conducted on shop and field-bolted and welded connections. Include data on type(s) of tests conducted and test results.

1.5 DELIVERY, STORAGE AND HANDLING.

1.5.01 Packing, Shipping, Handling and Unloading. Follow ASTM A700 Standard Practice for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.

1.5.02 Delivery of Material. Deliver items to jobsite as complete units, wherever practicable, ready for installation or erection with all anchors, hangers, fasteners and miscellaneous metal items required for installation.

Deliver, store and handle components in such a manner as to protect the finished surfaces from scratches, nicks, gouges, dents and other damage.

Identify, match, and mark all materials, items and fabrications, for installation and field assembly.

Deliver materials to site at such intervals to ensure uninterrupted progress of work.

Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, in ample time not to delay work.

1.5.03 Storage of Material. Store components in a dry, clean location, away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting. Keep handling to a minimum.

Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms or other supports. Protect steel members and packaged materials from erosion and deterioration. If bolts become dry or rusty, clean and relubricate before use.

Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed by the Engineer.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The fabricator is responsible for the design and provision of connections that meet performance standard established in the Contract Documents. Approval of Shop Drawings shall not relieve the fabricator of this responsibility.

Prior to preparing Detailed Shop Drawings, submit drawings showing typical details of connections, including framed beam connections, moment connections, and bracing connections. Include design calculations for these typical connections signed and sealed by a Professional Engineer registered in the State of Michigan. Base connection design on the load and reaction indicated and follow AISC requirements. For reactions not indicated on the drawings, design the connections to support ½ of the total allowable uniform load of the beam as given in the latest edition of the AISC Construction Manual. Arrange to meet with the Engineer at the Engineer’s office approximately one week after submittal to review drawings and basis for developing detailed Shop Drawings.

Submit calculations along with Shop Drawings, signed and sealed by a Professional Engineer registered in the State of Michigan, for any connection not previously approved as a typical connection.

2.2 MATERIALS.

2.2.01 Metal Surfaces - General. For fabrication of work that will be exposed to view, use only materials that are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding or by grinding, prior to cleaning, treating and applying surface finishes.

2.2.02 Steel.

Shapes, Plates and Bars	ASTM A36 or ASTM A572, Grade 50 as per Drawings, or ASTM A992/A992M
Sheets	ASTM A366 or A1011
Pipe	ASTM A53, Type E or S, Grade B; ASTM A500, Grade B, C, or D; or ASTM A501
Square and Rectangular Structural Tubing	ASTM A500, Grade B or C

2.2.03 Bolts and Nuts.

High Standard	ASTM A325, Type 1, tested in accordance with Article 9.2
Unfinished	ASTM A307
Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A

2.2.04 Washers.

Flat	ASTM F844
Flat, Hardened	ASTM F436
Lock	ANSI/ASME B18.21.1, helical spring type
Load Indicator	ASTM F959, compressible-washer-type direct tension indicator as manufactured by J&M Turner, Inc.; tested in accordance with Article 10.2 of ASTM F959.
Cast Iron	ASTM A48, Class 35B or better

2.2.05 Stainless Steel.

Plates	ASTM A240, Type 304L
Bolts	ASTM F593, Alloy Group 1 or 2
Nuts	ASTM F594, Alloy Group 1 or 2

Washers – Flat	ANSI B18.22.1
Washers – Lock	ANSI/ASME B18.21.1, helical spring type

2.2.06 Aluminum.

Sheet and Plate	ASTM B209, Alloy 6061-T6
Rolled Sections	ASTM B308, Alloy 6061-T6
Rod and Bar	ASTM B211, Alloy 6061-T6 or 2017-T4
Extrusions	ASTM B221, Alloy 6063-T5 or T6
Pipe	ASTM B429, Alloy 6061-T6 or 6063-T6
Bolts, Stainless Steel	ASTM F593, Alloy Group 1 or 2
Nuts, Stainless Steel	ASTM F594, Alloy Group 1 or 2
Washers – Flat	ANSI B18.22.1
Washers – Lock	ANSI/ASME B18.21.1, helical spring type
Checkered Plate	Alcoa C102, Alloy 6061-T6

Except as otherwise specified or indicated on the drawings, all materials and work shall conform to the applicable provisions of the AISC “Manual of Steel Construction – Allowable Stress Design”, Parts 1, 2, 3 and 4 and the “Specification for Structural Steel Buildings”.

2.2.07 Steel Castings. Provide ASTM A27, Grade 65-35, medium-strength carbon steel.

2.2.08 Structural Steel Primer Paint. Provide Universal rust-inhibiting primer, which can accept epoxy, epoxy esters and phenolic paints as finish coats.

2.3 MANUFACTURE AND FABRICATION. Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate for delivery sequence which expedites erection and minimizes material handling in field.

Structural steel items built into or anchored into masonry or concrete shall be completely fabricated and shall be furnished with bolts, anchors, clips and stud anchors to engage with adjacent construction.

Fabricate structural steel items in accord with AISC Specifications and details shown on reviewed and stamped final shop drawings.

Camber structural members to deflection shown or specified. If cambers are not shown, follow AISC specifications.

2.3.01 Shop Assembly. Properly mark and match-mark materials for field assembly. Where finishing is required, complete assembly, including unit welding, before starting finishing operations.

2.3.02 Shop Connections. Weld or bolt shop connections as shown. Install non-high-strength bolts, except where high-strength bolts are shown. Bolt field connections, except where welded connections or other connections are shown.

2.3.03 High-Strength Bolted Construction. Install and tighten high-strength threaded fasteners per ASTM A325.

2.3.04 Holes. Cut, drill or punch holes perpendicular to metal surfaces. (Drill holes in bearing plates) Do not flame cut holes or enlarge holes by burning.

Provide holes for securing other work to structural steel framing, and for passing other work through steel framing members, as shown on Shop Drawings.

2.3.05 Welded Construction. Comply with AWS Code for procedures, appearance and weld quality, and methods used in correcting welding work. Connections exposed after installation shall be continuously welded. Weld continuously along entire contact area except where tack welding is shown.

Assemble and weld built-up sections by methods, which produce, true axis alignment without warp.

2.3.06 Shear Connectors. Prepare steel surfaces as recommended by shear connector manufacturer. Shop weld shear connectors, spaced as shown, to beams or girders in composite construction. Automatic end weld headed stud shear connectors in accord with manufacturer's printed instructions.

2.3.07 Steel Wall Framing. Select members which are true and straight for steel wall framing fabrication. Straighten when required to provide uniform, square and true members throughout complete wall framing.

2.4 FINISHES. Shall be in accordance with Master Specification Section 09900, Painting.

2.4.01 Surface Preparation. After inspection and before shipping, clean steel work to be painted. Remove loose rust, loose mill scale and splatter, slag or flux deposits. Clean steel in accord with procedures defined in SSPC-SP10 "Near-White Blast Cleaning."

2.4.02 Shop Priming. Immediately after surface preparation, apply structural steel primer paint in accord with manufacturer's instructions at rates that provide not less than 1.5 mils (0.04 mm) dry film thickness or as directed in Master Specification Section 09900, Painting. Prime embedded steel, which is partially exposed on exposed portions.

Do not prime initial 2 inches (5.1 cm) of embedded areas. Do not prime surfaces which are to be welded or high-strength bolted with friction-type connections. Do not prime surfaces which are scheduled to receive sprayed-on fireproofing.

2.4.03 Application of Coating. Galvanize steel members, fabrications and assemblies after fabrication by hot-dip process in accord with ASTM A123.

2.4.04 Shop Painting. Use painting methods which result in full coverage of joints, corners, edges and exposed surfaces. Apply two coats of paint to surfaces which are inaccessible after assembly or erection. Change second coat color to distinguish it from first.

2.4.05 Bituminous Coating. SSPC – paint 12, solvent type bituminous mastic, normally free of sulfur compound for 15 mil dry film thickness per coat.

2.5 SHOP COATINGS. All structural and miscellaneous metal items shall be shop coated as specified. Surfaces shall be dry and of proper temperature when coated, and shall be free of grease, oil, dirt, dust, grit, rust, loose mill scale, weld flux, slag, weld spatter and other objectionable substances. Articles to be galvanized shall be pickled before galvanizing. All other ferrous metal surfaces shall be cleaned by high-speed power wire brushing or by blasting to the extent recommended by the paint manufacturer. Welds shall be scraped, chipped and brushed to remove all weld spatter.

Sharp projections of cut or sheared edges of ferrous metals which will be submerged in operation, except for items specified to be hot-dip galvanized, shall be ground to a radius as required to ensure satisfactory paint adherence.

The coating weight shall conform with ASTM A123 or Table 1, ASTM A153. The surface finish shall be continuous, adherent, smooth, evenly distributed and free from defects detrimental to coated article's stated end use. Adhesion shall withstand normal handling consistent with coating nature and thickness and normal article use.

2.5.02 Castings. Shop coating of miscellaneous iron castings will not be required.

2.5.03 Steel. Unless otherwise specified, all ungalvanized structural and miscellaneous steel shall be given a universal prime coat in the shop after fabrication. Unless galvanized, bar joists shall receive a shop coat of red oxide primer and a field coat of universal primer which must be compatible with both the primer and finish coating. Steel surfaces shall be prime-coated as soon as practicable after cleaning. All painting shall be done in a heated structure if the outside air temperature is below 50 degrees F (10 degrees C). Steel shall not be moved or handled until the shop coat is dry and hard. Structural tubes and headers for Roll-Up Doors shall be galvanized.

2.5.04 Stainless Steel. Unless otherwise specified or permitted, all items fabricated from stainless steel shall be thoroughly cleaned, degreased and passivated after fabrication. Passivating shall produce a modest etch and shall remove all embedded iron and heat tint. Passivated surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be repassivated as required to remove all traces of iron contamination. Passivated surfaces shall be adequately protected during shipping, handling and installation to prevent contact with iron or steel objects or surfaces. Blast cleaning of stainless steel will not be acceptable.

2.5.05 Other Surfaces. Shop coating of zinc coated steel, stainless steel or bronze surfaces will not be required.

2.5.06 Film Thickness. The dry film thickness of the shop coating shall be at least 2 mils (0.05 mm) for universal primer and at least 5 mils (0.1 mm) for epoxy enamel.

2.6 CONTROLS.

2.6.01 Testing. Provide access for testing agency to places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

Testing agency may inspect structural steel at plant before shipment. The Engineer reserves the right, at any time before final inspection, to reject material not complying with specified requirements.

PART 3 – EXECUTION

3.1 INSPECTION. Structural and miscellaneous metal work shall be fabricated in conformity with dimensions, arrangements, sizes and weights or thicknesses as specified or indicated on the drawings.

All members and parts, as delivered and erected, shall be free of kinks, warps, local deformations and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. Erection drawings shall be prepared and each separate piece shall be marked as indicated thereon. All field connection materials shall be furnished.

Structural and miscellaneous metal work shall be stored on blocking so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

Before assembly, surfaces to be in contact with each other shall be thoroughly cleaned. All parts shall be assembled accurately as indicated on the drawings. Light drifting will be permitted to draw parts together, but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with twist drills. Enlarging holes by burning will not be permitted.

3.2 PREPARATION. Employ Professional Engineers or Land Surveyors for accurate structural steel layout and location measurements. Check concrete and masonry bearing surface elevations, and anchor bolts and similar device locations before beginning erection work. Report discrepancies to Engineer. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Engineer.

Clean steel bearing surfaces and other surfaces which shall be in permanent contact before assembly.

Clean bond-reducing materials from concrete and masonry bearing surfaces and roughen to improve bond-to surfaces. Clean base and bearing plate bottom surfaces.

3.3 INSTALLATION.

3.3.01 Erection. Erect structural steel in accordance with AISC Specifications.

Structural steel shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevations of the top of the floor and of the roof members shall be within 1/16 inch (1.6 mm) of the elevations indicated on the drawings. The faces of girts and other supporting members for rigid wall panels shall be in vertical planes within a maximum variation of 1/8 inch (3.2 mm). Base plates shall be set level in exact position and grouted in place.

Do not field cut or alter structural members. After erection, prime welds, abrasions and surfaces not primed.

Unless otherwise acceptable to the Engineer, a platform or other means of access shall be provided at each field connection to facilitate inspection.

3.3.02 Setting Bases and Bearing Plates. Set attached and unattached base plates and bearing plates for structural members on wedges, shims or adjusting nuts or other adjusting devices.

Tighten anchor bolts after supporting members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with base edge or bearing plate before packing with grout.

3.3.03 Protection. Provide temporary shores, guys, and bracing members with sufficiently strong connections to bear imposed loads during erection. Also keep structural steel secure, plumb and in alignment against temporary construction loads.

Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment as erection proceeds.

3.3.04 Site Tolerances. Establish required leveling and plumbing measurements on mean operating temperature of structure. Level and plumb individual structure members within AISC tolerances.

Set structural steel accurately in locations and to lines and elevations shown. Comply with AISC Specifications for bearing, temporary connections, alignment and paint removal on surfaces. Splice members only where shown and accepted on shop drawings. Align and adjust various members forming complete frame elements or structure(s) before permanently fastening.

3.3.05 Connections. Unless otherwise noted, connections shall conform to the details indicated on the drawings.

Unless welded connections are noted on the drawings, the shop fabricated portions of structural connections may be welded or bolted. The shop portion of beam-to-column connections shall be attached to the beam unless otherwise indicated on the drawings.

Unless otherwise noted, bolted connections for structural steel, as defined in the AISC manual, shall be made with ASTM A325 high strength bolts equipped with load indicator washers.

Field-welded connections will not be acceptable for structural steel unless indicated on the drawings.

Connections for miscellaneous steel fabrications not included in the AISC definition of structural steel may be made with unfinished bolts. All unfinished bolts shall be equipped with self-locking nuts or with unfinished nuts and lock washers.

Bolted connections shall be friction type, except where other types are specifically indicated on the drawings. Contact surfaces of friction connections shall not be painted. When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts or washers, shall be free of loose mill scale, dirt, burrs, oil, paint, lacquer, galvanizing and other foreign material that would prevent solid seating of the parts.

Bolt holes shall have a diameter nominally 1/16 inch (1.6 mm) larger than the nominal bolt diameter. Bolt holes for 1 ply only of vertical diagonal bracing connections may be oversized to a diameter nominally 3/16 inch (4.8 mm) larger than the nominal bolt diameter. If oversized holes are provided in an outer ply, a hardened flat washer shall be installed over each hole during bolting. Slotted holes shall not be used except for girt connections and other locations specifically indicated on the drawings.

Only light drifting shall be permitted to draw parts together. Drifting to match unfit holes shall not be permitted. Do not enlarge unfit holes in members by burning. Hole enlargements essential to make connections shall be done by reaming and twist drills and using proper size bolts. Do not enlarge unfit holes in members by use of drift pins, except in secondary bracing members.

3.3.06 Bolted Structural Connections. Except as modified or supplemented herein, high strength bolts, the method of installation, and bolting tools and equipment shall conform to the requirements of the “Specification for Structural Joints Using ASTM A325 or A490 Bolts” as approved by the Research Council on Structural Connections. Bolt length shall be increased 1/8 inch (3.2 mm) to allow for the thickness of the installed load indicator washer, 1/4 inch (6.4 mm) if the indicator washer is used in conjunction with one hardened flat washer and 3/8 inch (9.5 mm) if two flat washers are required.

Load indicator washers shall be installed in accordance with the manufacturer’s recommendations, as supplemented herein.

To facilitate proper tightening of fastener assemblies, a hardened flat washer shall be installed under the turned element (bolt head or nut) and between the turned element and the indicator washer protrusions in all cases.

Whenever possible, the indicator washer shall be installed on the head end of the bolt. If the bolt head will not be visible for inspection of the indicator washer after inspection, or if the bolt head must be turned to tighten the assembly, the indicator washer may be installed on the nut end of the bolt.

Tightening of each assembly shall progress systematically from the most rigid part of the joint toward the free edges until the indicator washers on all bolts have been closed to the average gap stipulated by the washer manufacturer.

Load indicator washers shall not be substituted for the hardened flat washers required for oversized holes in the outer ply of vertical diagonal bracing connections.

3.3.07 Gas Cutting. Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting is permitted only on secondary members which are not under stress. (When authorized, finish gas-cut sections equal to sheared appearances.)

3.3.08 Structural And Miscellaneous Aluminum. Connections not specifically detailed on the drawings shall develop the full strength of the least strength member of the connection.

Unless otherwise noted, connections shall be all-bolted bearing type, using 3/4 inch (1.9 cm) bolts and nuts equipped with a helical spring lock washer under the stationary element (bolt head or nut) and a flat washer under the turned element. Bolts and nuts for structural aluminum and aluminum stair connections shall be stainless steel. Bolts and nuts for nonstructural miscellaneous aluminum assemblies shall be aluminum. A sufficient number of bolts shall be provided in each connection to develop the shear strength of the members. Unless otherwise noted, welded connections will not be acceptable.

Structural aluminum shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevation of horizontal members shall be within 1/16 inch (1.6 mm) of the elevation indicated on the drawings.
Baseplates shall be set level in exact position and grouted in place.

3.3.9 Touch-Up Painting. Immediately after erection, clean field welds, bolted connections and abraded areas. Apply some paint to exposed areas using same material as used for final painting. Apply touch-up paint by brush or spray to provide 1.5 mils (0.04 mm) dry film thickness, minimum.

Remove temporary shoring, members, guys, bracing and connections when permanent members are in place and final connections made and tested.

Clean field welds, bolted connections and abraded areas, and apply galvanizing repair paint according to ASTM A780.

3.4 FIELD QUALITY CONTROL. Engage independent testing and inspection agencies to inspect high-strength bolted connections, welded connections, to conduct tests, and prepare test reports.

Testing agency shall conduct and interpret tests, state in each report whether test specimens comply with requirements, and specifically identify any deviations.

Provide access for testing agency to places where structural steel work is being assembled, so that required inspection and testing can be accomplished.

High-Strength Field-Bolted Connections shall be tested and inspected according to RCSC's "Specification of Structural Joints Using ASTM A325 bolts." Direct tension indicator gaps shall be verified to comply with ASTM F959, Table 2.

3.4.01 Adjusting. Errors in shop or field work which prevents proper assembling and parts fitting by moderate drift pin use, or moderate reaming and slight clipping, shall be corrected at Contractor's expense.

End of Section

SECTION 05210

STEEL JOISTS

PART 1 – GENERAL

1.1 SCOPE. This section includes structural steel open web joists, long span joists, deep long span joists, and joists girders for roof and floor framing. Anchorage, bearing plates, and shop finishing are also included in this section.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations as set in the following standards:

ASTM (American Society for Testing and Materials) A36/A36M – Specification for Carbon Structural Steel.

ASTM A108 – Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.

ASTM A123/A123M – Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.

ASTM A153/A153M – Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60 ksi Tensile Strength.

ASTM A325 – Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

AWS (American Welding Society) D1.1 – Structural Welding Code.

SJI (Steel Joist Institute) – Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders.

SSPC (Steel Structures Painting Council) – Steel Structures Painting Manual.

SSPC SP 1 – Sealant Cleaning.

SSPC SP 10 – Near White Blast Cleaning.

SSPC Paint No. 15 – Steel Joint Shop Paint Type 1, red oxide.

SSPC Paint No. 20 – Zinc Rich Primers, Type 1 (Inorganic), Type II (Organic).

1.3 QUALITY ASSURANCE. Perform Work in accordance with SJI Load Tables, and Weight Tables, including headers and other supplementary framing.

1.3.01 Contractor Qualifications. Fabricator and erector contractors shall specialize in performing Work of this section and shall have a minimum of 5 years documented experience.

Design connections not detailed on the drawings shall be designed under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of Michigan.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate standard designations, configuration, sizes, spacing, locations of joists and joists leg extensions.

1.4.02 Certifications. Submit certificates that welders employed on the Work have certified within the previous 12 months and meet AWS qualifications.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers include Butler Manufacturing Co., New Millennium Building Systems LLC, Vulcraft Steel Joist, or an approved equal.

2.2 MATERIALS.

2.2.01 Open Web Joists Members. Members include: SJI Type K or LH Longspan, DLH Deep Longspan and DLH Deep Joist Girders.

2.2.02 Anchor Bolts, Nuts and Washer Assemblies. Assemblies shall be per ASTM A307 or A325, galvanized to ASTM A153.

2.2.03 Shear Stud Connectors. Connectors shall be per ASTM A108, forged steel headed and uncoated.

2.2.04 Structural Steel. Supplementary framing and joist leg extensions shall be per ASTM A36.

2.2.05 Welding Materials. Materials shall be per AWS D1.1 type required for materials being welded.

2.2.06 Shop and Touch-up Primer. Primer shall be per SSPC 15 Type 1 red oxide.

2.2.07 Touch-up Primer for Galvanized Surfaces. Primer shall be per SSPC 20 Type I Inorganic or Type II Organic.

2.3 FABRICATION. Provide bottom and top chord extensions as indicated. Drill holes in chords necessary for attachment of wood nailers. Weld threaded lugs to chords for attachment of wood nailers. Fabricate to achieve end bearing of 2 1/2 inches (6.4 cm) on steel and 4 inches (10.2 cm) on masonry. Frame special sized openings in joist web framing as detailed. Space stud shear connectors as detailed.

2.4 FINISH. Prepare joist component surfaces in accordance with SSPC SP 2.

Shop prime joists and supplementary framing members. Do not prime surfaces that will be fireproofed, field welded, or in contact with concrete.

Galvanize steel ledge angles, and anchors to ASTM A123. Provide minimum 1.25 ounce per square foot (381.4 g per sq m) galvanized coating.

PART 3 – EXECUTION

3.1 INSTALLATION. Erect and bear joists on supports. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment. Coordinate placement of anchors in concrete or masonry construction for securing bearing plate and angles.

After joist alignment and installation of framing, field weld joist seat to bearing plates and angles. Position and field weld joist chord extensions and wall attachments as detailed. Do not field cut or alter structural members without approval of joist manufacturer.

Do not permit erection of decking until joists are braced, bridged, secured or until completion of erection and installation of permanent bridging and bracing. After erection, prime welds, abrasions, and surfaces not shop primed except surfaces to be in contact with concrete.

3.1.02 Erection Tolerances. Maximum variation from plumb shall be 1/4 inch (6.4 mm). Maximum offset from true alignment shall be 1/4 inch (6.4 mm).

3.2 FIELD QUALITY CONTROL. Provide shop testing and analysis of steel sections.

End of Section

SECTION 05310

METAL FLOOR DECK

PART 1 – GENERAL

1.1 SCOPE. This section contains shop formed, cellular or non-cellular, and plain or ribbed, structural metal floor deck, including miscellaneous accessories.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements set forth in the current publications and addenda thereto of the following standards:

AISI (American Iron and Steel Institute) – Specification for the Design of Cold-Formed Steel Structural Members.

ASTM (American Society for Testing and Materials) A36/A36M - Specification for Carbon Structural Steel.

ASTM (American Society for Testing and Materials) A108 - Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

AWS (American Welding Society) D1.1 – Structural Welding Code – Steel.

AWS D1.3 – Structural Welding Code – Sheet Steel.

DOD-P-21035A (Military Specification) – Paint, High Zinc Dust Content, Galvanizing Repair.

SDI (Steel Deck Institute) – Design Manual for Composite Decks, Form Decks, Roof Decks, Cellular Metal Floor Deck with Electrical Distribution.

SSPC (Steel Structures Painting Council) – Painting Manual. SSPC Paint No. 15, Steel Joist Shop Paint Type 1, red oxide; SSPC-20, Type I – Inorganic; and SSPC-20, Type II – Organic.

UL (Underwriters Laboratories, Inc.) – Fire Resistance Directory.

1.3 QUALITY ASSURANCE. Comply with provisions of the following codes and standards, except as otherwise indicated: American Iron and Steel Institute (AISI) “Specification for the Design of Cold-Formed Steel Structural Members,” and Steel Deck Institute (SDI) “Design Manual for Composite Decks, Form Decks and Roof Decks.”

1.3.01 Welding Qualifications. Comply with Metal Fabrication section and applicable provisions of AWS D1.1 “Structural Welding Code-Steel” and AWS D1.3 “Structural Welding Code-Sheet Steel.” Submit welder certificates signed by Contractor certifying that welders comply with requirements specified under the “Quality Assurance” article. Certify welders employed on the Work, verifying AWS qualification within the previous 12 months.

1.3.02 Engineer Qualifications. The design engineer shall be legally authorized to practice in the State of Michigan and experienced in providing engineering services of this type with a record of successful performance.

1.3.03 Installer Qualifications. Engage an experienced installer with 5 years successful documented experience installing steel decks of this type.

1.3.04 Testing Agency Qualifications. To qualify for acceptance, an independent testing agency must demonstrate to Engineer’s satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Project.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete shop drawings showing metal deck placement, location of stud shear connectors, and large scale cross-sectional detail of deck. Include details showing stud shear connectors, bearing lengths, methods of attachment of deck and accessories, reinforcing of openings and other pertinent sections. Show details required for installation and erection of metal deck and stud shear connectors. Indicate deck plan, support locations, projections, reinforcement, cellular raceways, outlet box locations and other pertinent details.

For steel deck indicated to comply with certain design loadings, include structural analysis data sealed and signed by the qualified professional engineer who was responsible for its preparation.

Submit product data for each type of deck, accessory and product specified. Submit manufacturer's installation instructions with detailed sketches and installation sequence.

1.4.02 Certifications. Submit product certificates signed by manufacturers of steel deck certifying that their products comply with specified requirements.

1.5 DELIVERY, STORAGE AND HANDLING. Protect steel deck from corrosion, deformation, and other damage during delivery, storage and handling. Cut plastic wrap to encourage ventilation. Do not use decking for storage or as working platforms until it has been permanently secured in position. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Design metal deck in accordance with SDI Design Manual. Calculate to structural working stress design and maximum vertical deck deflection of 1/240 of the span.

2.1.01 Deck Requirements. Composite steel floor deck and concrete, of specified type and thickness, which is indicated to be fire-rated, shall be listed in the UL Fire Resistance Directory under the applicable Design No. for 2 hour rating and bear the UL listing mark.

2.1.02 Deck Type and Manufacturer. Deck nominal depth shall be 2 inches (5.08 cm) with a minimum flute spacing of 12 inches (30.48 cm) on centers. Minimum average width of flutes between webs shall be 6 inches (15.24 cm). The Side lap shall be of vertical male and female type.

2.2 ACCEPTABLE MANUFACTURERS. Subject to compliance with requirements, provide products by one of the following or an approved equal:

ASC Pacific, Inc.

CANAM Steel Corp.
Consolidated Systems, Inc.
Epic Metals Corp.
Marlyn Steel Products, Inc.
New Millennium Building Systems, LLC.

Roof Deck, Inc.

Verco Manufacturing Co.
Vulcraft Div. Of Nucor Corp.
Walker Div. Of Butler Manufacturing Co.

2.3 MATERIALS.

2.3.01 Noncomposite Steel Form Deck. Fabricate ribbed-steel sheet noncomposite form deck panels conforming to SDI Publication No. 28 “Specifications and Commentary for Noncomposite Steel Form Deck.”

2.3.02 Galvanized-Steel Sheet. Shall be ASTM A653, Grade A, with G90 galvanized coating according to ASTM A653. Profile depth shall be 1 1/2 inches (3.8 cm). Design uncoated-steel thickness shall be 0.0358 inch (0.9 mm). Span condition shall be triple span or more. Side joints shall be overlapped or interlocking seam at Contractor’s options. For acoustical perforations and sound insulations, provide deck panels with manufacturer’s standard perforated vertical webs. Provide non-organic glass fiber sound absorbing batts in rib openings.

2.3.03 Welding Materials. Shall comply with AWS D1.1.

2.3.04 Metal Closure Strips, Cover Plates and Related Accessories. Provide 18 gage (1.3 mm) sheet steel of required profiles and size. G90 coating shall conform to ASTM A653.

2.3.05 Bearing Plates and Angles. Provide ASTM steel, unfinished.

2.3.06 Paint and Printer. Shall be in accordance with Master Specification Section, 09900, Painting. Provide manufacturer’s baked-on, rust-inhibitive paint, for application to metal surfaces that have been chemically cleaned and phosphate chemical treated. Provide SSPC Paint No. 15, Steel Joist Shop Paint Type 1, red oxide.

2.3.07 Stud Shear Connectors. Provide ASTM A108 Grade 1015 forged steel, heated, uncoated.

2.4 MANUFACTURE AND FABRICATION. Fabricate deck units and accessories of zinc coated steel sheets of structural quality complying with ASTM A653, quality SQ, Grade 33 ksi (227.5 MPa), with coating designation (G90). Furnish zinc coating which is compatible with the composite action for deck performance.

Fabricate deck units and accessories of flat-rolled carbon steel sheets of structural quality, complying with ASTM A1008 Grade C (33 ksi (227.5 MPa) yield), with top surface (in contact with concrete) phosphate-treated and prime painted with a manufacturer's standard primer on the exposed side.

Provide coating which is compatible with materials specified in Master Specification Section 07950, Firestopping and Smokestopping.

Form deck units in lengths to span three or more supports, with flush, telescoped, or nested 2 inch (5.1 cm) laps at ends and interlocking or nested side laps, of metal thickness, depth, and width as indicated.

Provide decking with integral embossing or raised pattern to furnish mechanical bond between deck and concrete. Demonstrate the composite load carrying capacity of slab system by load tests performed under the supervision of a Professional Engineer. Based on the test results, establish the allowable loads and submit to the Engineer upon written request.

2.4.01 Unit Construction. Design thickness of uncoated sheet steel for deck units shall be 0.0474 inch (1.2 mm) – Type No. 18. Closures shall use 0.0474 inch (1.2 mm) – Type No. 18 and for reinforcing use 0.0747 inch (1.9 mm) – Type No. 14.

The maximum permissible negative tolerance from the design thickness shall be 5 percent.

2.4.02 Metal Closure Strips. Fabricate metal closure strips, for cell raceways and openings between deckings and other construction, of not less than 18 gage (1.3 mm) sheet steel. Form to provide tight-fitting closures at open ends of cells or flutes and sides of decking.

2.4.03 Floor Drain Pan. Fabricate of sheet steel with flat bottom and sloped sides, recessed 1 1/2 inches (3.8 cm) below floor deck surface, bearing flange 3 inches (7.6 cm) wide, sealed watertight.

2.4.04 Fasteners. Provide stainless or galvanized hardened steel fasteners, self tapping.

2.4.05 Weld Washers. Provide mild steel, uncoated 3/4 inch (1.9 cm) outside diameter, 1/8 inch (3.2 mm) thick.

2.5 ACCESSORIES. Provide accessory materials for steel deck that comply with requirements indicated and recommendations of the steel deck manufacturer.

2.5.01 Mechanical Fasteners. Provide manufacturer's standard, corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon steel fasteners, or self-drilling, self-threading screws.

2.5.02 Side Lap Fasteners. Provide manufacturer's standard, corrosion-resistant, hexagonal washer head, self-drilling, carbon steel screws, No. 10 minimum diameter.

2.5.03 Rib Closure Strips. Provide manufacturer's standard vulcanized, closed-cell, synthetic rubber.

2.5.04 Miscellaneous Roof Deck Accessories. Provide steel sheet, 0.0359 inch (0.9 mm) thick minimum ridge and valley plates, finish strips and reinforcing channels of same material as roof deck.

2.5.05 Pour Stops and Girder Fillers. Provide steel sheet, of same material as deck panels, and of thickness, and profile indicated with sufficient strength and thickness to support the weight of wet concrete plus 20 psf (0.96 kPa) construction load.

2.5.06 Column Closures, End Closures, Z-Closures and Cover Plates. Provide steel sheet, of same material and thickness as deck panels, unless otherwise indicated.

2.5.07 Weld Washers. Provide manufacturer's standard uncoated-steel sheet weld washers, shaped to fit deck rib, 0.0598 inch (1.5 mm) thick with 3/8-inch (9.5 mm) minimum diameter prepunched hole.

2.5.08 Recessed Sump Pans. Provide manufacturer's standard size, single piece steel sheet 0.071 inch (1.8 mm) thick minimum, of same material as deck panels, with 1 1/2 inch (3.8 cm) minimum deep level recessed pans and 3 inch (7.6 cm) wide flanges. Cut holes for drains in the field.

2.5.09 Steel Sheet Accessories. Shall be ASTM A653, G60 coating class, galvanized according to ASTM A653.

2.5.10 Galvanizing Repair Paint. Shall be SSPC-Paint No. 20 or DOD-P-21035, with dry film containing a minimum of 94 percent zinc dust by weight.

2.5.11 Shear Connectors. Provide headed stud shear connectors made from ASTM A108, Grade Designation 1015 material, and conforming to AWS, D1.1, Table 7-1, Type B.

PART 3 – EXECUTION

3.1 INSPECTION. Examine supporting framing and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of steel deck.

3.2 PREPARATION. Do not place deck panels on concrete supporting structure until concrete has cured and is dry. Locate decking bundles to prevent overloading of supporting members.

3.3 INSTALLATION. Install deck panels and accessories according to applicable specifications and commentary of SDI Publication No. 28, manufacturer’s recommendations, and requirements of this Section.

Install temporary shoring before placing deck panels when required to meet deflection limitations.

Place deck panels on supporting framing and adjust to final position with ends accurately aligned and bearing on supporting framing before being permanently fastened. Do not stretch or contract side lap interlocks.

Place deck panels flat and square and fasten to supporting framing without warp or deflection.

Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to the decking.

Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.

Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds and methods used in correcting welding work. Use welding washers where recommended by deck manufacturer. Mechanical fasteners, either powder-actuated or pneumatically driven, may be used in lieu of welding. Locate mechanical fasteners and install in accordance with deck manufacturer’s instructions.

Fasten roof deck units to steel supporting members by not less than 1/2 inch (1.3 cm) diameter puddle welds or elongated welds of equal strength, spaced not more than 12 inches (30.5 cm) at every support, and at closer spacing where indicated. In addition, secure deck to each supporting member in ribs where side laps occur.

Mechanically fasten side laps of adjacent deck units between supports, at intervals not exceeding 36 inches (91.4 cm) o.c., using self-tapping No. 8 or larger machine screws.

3.3.01 Uplift Loading. Install and anchor roof deck units to resist gross uplift loading of 30 psf (1.44 kPa) at eave overhang and 20 psf (0.96 kPa) for other roof areas.

3.3.02 Cutting and Fitting. Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking, as shown.

3.3.03 Reinforcement at Openings. Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work shown.

3.3.04 Closure Strips. Provide metal closure strips at open uncovered ends and edges of decking and in voids between decking and other construction. Weld into position to provide a complete decking installation.

Provide flexible closure strips instead of metal closures, at Contractor’s option, wherever their use will ensure complete closure. Install with adhesive in accordance with manufacturer’s instructions.

3.3.05 Touch-Up Painting. After decking installation, wire brush, clean and paint scarred areas, welds and rust spots on top and bottom surfaces of decking units and supporting steel members. Touch up painted surfaces with same type of shop paint used on adjacent surfaces.

3.4 REPAIRS AND PROTECTION. Prepare and repair damaged galvanized coatings on surfaces with galvanized repair paint according to ASTM A780 and the manufacturer’s instructions.

Provide final protection and maintain conditions to ensure steel decking is without damage or deterioration at time of Substantial Completion.

End of Section

SECTION 05311

STEEL ROOF DECK

PART 1 – GENERAL

1.1 SCOPE. This section includes shop formed, non-cellular, acoustic or non-acoustic type, structural steel roof deck with miscellaneous accessories.

1.2 GENERAL.

1.2.01 Governing Standards. Shall comply with the requirements set forth in the following standards:

ASTM (American Society of Testing Materials) A36/A36M – Specification for Carbon Structural Steel.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

AWS (American Welding Society) D1.1 – Structural Welding Code - Steel.

AWS D1.3 – Structural Welding Code - Sheet Steel.

SDI (Steel Deck Institute) - Design Manual for Composite Decks, Form Decks, Roof Decks, Cellular Metal Floor Deck with Electrical Distribution.

SSPC (Steel Structures Painting Council) – Painting Manual. SSPC Paint No. 15 Steel Joist Shop Paint Type 1, red oxide; SSPC-20 Type 1 – Inorganic; and SSPC-20 Type II – Organic.

1.3 QUALITY ASSURANCE. Comply with provisions of the following codes and standards, except as otherwise indicated: American Iron and Steel Institute (AISI), “Specification for the Design of Cold-Formed Steel Structural Members,” and Steel Deck Institute (SDI), “Design Manual for Composite Decks, Form Decks and Roof Decks.”

1.3.01 Welding Qualifications. Comply with applicable provisions of AWS D1.1 “Structural Welding Code – Steel” and AWS D1.3 “Structural Welding Code – Sheet Steel.” Certify that welders on the work have passed AWS qualification tests for welding processes involved within the previous 12 months or undergone re-certification if needed.

1.3.02 FM Listing. Provide steel roof deck evaluated by Factory Mutual and listed in Factory Mutual “Approval Guide” for Class 1 fire rating and Class 1-60 windstorm ratings.

1.3.03 Engineer Qualifications. The design engineer shall be legally authorized to practice in the State of Michigan and experienced in providing engineering services of this type with a record of successful performance.

1.3.04 Installer Qualifications. Engage an experienced installer who has completed steel deck similar in material, design and extent to that indicated for this project and with a record of successful in-service performance.

1.3.05 Testing Agency Qualifications. To qualify for acceptance, an independent testing agency must demonstrate to Engineer’s satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Project.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details and accessories. Drawings shall indicate sizes and locations of roof framing supports and the depths, profiles, thicknesses, locations, lengths and markings of deck units to correspond with the sequence of installation. Drawings shall indicate fastening methods for deck units, accessories, closure pieces, fittings, and auxiliary supports, and the type and sequence of welded connections.

Submit deck profile characteristics and dimensions, structural properties and finishes. Submit producer’s or manufacturer’s data for products. Include sufficient data to show compliance with roof deck manufacturer, accessories manufacturer, type of deck and mill certificates. Submit manufacturer’s installation instructions.

1.4.02 Certificates. Certify that products meet or exceed specified requirements.

1.5 DELIVERY, STORAGE AND HANDLING. Protect steel deck from corrosion, deformation, and other damage during delivery, storage and handling. Cut plastic wrap to encourage ventilation. Separate sheets and store deck on dry wood sleepers. Slope for positive drainage. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Galvanized steel for metal roof decking and accessories shall conform to ASTM Designation A653 Grade A having a minimum yield strength of 33,000 psi (227.5 MPa). The unit design stress shall not excel 20,000 psi (137.9 MPa). Galvanizing shall be by the hot dipped process conforming to ASTM Designation A653, Coating Class G90. Live load deflection shall not exceed 1/240 of the span.

Submit mill certificates to the Engineer as evidence that the steel decking conforms to the above requirements.

2.2 MATERIALS.

2.2.01 Wide Rib Type B Deck. Type B. metal roof decking shall be galvanized steel sections with ribs not less than 1 1/2 inches (3.8 cm) deep, 6 inches (15.2 cm) on center, with ends formed to telescope at end laps and of sufficient length to bear on at least four supports. Longitudinal rib openings, measured on top surface of deck shall not be more than 2 1/2 inches (6.3 cm) wide. Top surface of deck shall be flat, without stiffening grooves. Sheet steel for decking, before galvanizing, shall be 20 gauge (1.0 mm) thickness or 18 gauge (1.3 mm) thickness as indicated on the drawings. Material shall be by one of the following manufacturers:

Wheeling Corrugating Company,

United Steel Deck, Inc.,

Vulcraft,

Consolidated Systems, Inc.,

Or equal

2.3 ACCESSORIES. Roof sump pans shall be standard 14 gauge (2.0 mm) galvanized sheet steel, flat or recessed type, suitable to receive roof sumps.

Cant strips and closure plates shall be not less than 20 gauge (1.0 mm) thickness galvanized sheet steel, formed, flanged and prepared for each particular installation. Edges to be nailed shall be punched with 3/16 inch (4.8 mm) diameter holes at 8 inches (20.3 cm) on centers.

Unless otherwise indicated on the drawings, attachments shall secure the deck to the structure against a net uplift of at least 60 psf (2.87 kPa) along the roof perimeter for at least 10 feet (3 m) from the interior walls and at eave overhangs. In all other roof areas, deck attachments shall secure the deck to the structure against a net uplift of at least 30 psf (1.44 kPa).

All accessories, such as flashings, closure pieces, roof drain sumps, metal cants, and other items as indicated or required, shall be fabricated of the same material and finish as deck units, in the thicknesses indicated or recommended by the deck manufacturer. Accessories shall be welded in place or secured with self-tapping screws.

2.4 COLD GALVANIZING COMPOUND FOR GALVANIZED SURFACES. ZRC Products Company, or as approved.

2.5 FASTENERS. Galvanized hardened, self-tapping.

PART 3 – EXECUTION

3.1 INSTALLATION. Verify existing conditions prior to beginning Work. Erect metal deck in accordance with SDI Manual and manufacturer's instructions. Bear deck on steel supports with 1-1/2 inch minimum bearing. Align and level. Weld in accordance with AWS D1.1.

Ends of adjacent deck units shall be staggered on supporting members so that ends are not terminated on any one supporting member except at roof edges or at roof openings.

Deck units shall start and terminate at the center of supporting member at ends of runs, at roof openings or elsewhere as required. Panels must be driven up snug before welding to supporting members. Provide and install vertical sections of metal decking where required.

Unless otherwise indicated on the drawings, roof deck panels shall be secured to each supporting member with fusion welds at least 5/8 inch (1.6 cm) in diameter at 8 inch (20.3 cm) centers unless otherwise indicated. Deck edges shall be secured to perimeter members parallel to the deck span at 6 inch (15.2 cm) centers with fusion welds at least 5/8 inch (1.6 cm) in diameter. Welds shall seal the metal completely, leaving no openings through the deck. Welds shall penetrate all layers of deck material at the point of welding and shall achieve complete fusion to the supporting member. Suitable welding washers shall be used if welds satisfactory to the Engineer cannot be achieved.

Deck unit side laps shall be screw fastened, with self-drilling, self-tapping, cadmium plated sheet metal screws 3/4 inch (1.9 cm) in length at supporting members and 12 inch (30.5 cm) centers between supporting members unless otherwise indicated.

Care shall be taken not to fasten the joints with one panel depressed below adjoining panels.

Sheet metal screws shall be similar to Teks hex washer head 10-16 x 3/4 inch (1.9 cm) in length.

Roof openings shall be provided in deck for roof sump pans, vent pipes, hatches, curbed roof openings and other openings as required. Also provide openings in roof sump pans for sump installations in sizes as required. Cut holes neatly without ragged edges.

Unless indicated otherwise on the drawings, reinforce the deck at all roof sumps and other roof openings, on the underside, with two 2 stiffener angles of sufficient length to extend three 3 ribs beyond each side of openings. Weld angles to each rib.

Install sheet steel closures and angle flashings to close openings between deck and walls, columns, and openings. Position roof sump pans with flange bearing on top surface of deck. Fusion-weld each deck flute. Place metal cant strips in position and fusion-weld. Immediately after welding deck and other components in position, coat welds, burned areas, and damaged surface coating with two coats of cold galvanizing compound which imparts cathodic action against corrosion. Surface preparation and application shall be in accordance with the manufacturer's instructions.

3.1.01 Valley and Peak Construction. Where the roof deck has a pitch of 1/8 inch per ft. (3.2 cm per 30.5 cm) or greater on slopes between valleys and peaks and where the decking strips are to be laid at right angles to lines of valleys and peaks, the decking shall not be laid continuously across valleys or peaks. All strips of decking for the sloped roof surfaces shall be terminated at valleys and peaks by butt joints in straight lines parallel with valley and peak lines. These valley and peak joints shall be covered with 8 inch (20.3 cm) wide bent galvanized sheet steel closures, of the same thickness as the decking and they shall be welded to the decking along one side only.

End of Section

SECTION 05400

COLD-FORMED METAL FRAMING

PART 1 – GENERAL

1.1 SCOPE. This section includes axially loaded steel studs, slotted channels, joists, purlin framing and connections, usually of 0.033 inch (0.8 mm) to 0.097 inch (2.5 mm) metal thickness. Section also includes bracing, fasteners and accessories.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

AISI (American Iron and Steel Institute) – Cold-Formed Steel Design Manual.

ASTM (American Society of Testing Materials) A123/A123M – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A645/A645M - Specification for Pressure Vessel Plates, Five Percent Nickel Alloy Steel, Specially Heat Treated.

ASTM A653/A653M - Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A780 – Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

ASTM A924/A924M – Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High Strength Low-Alloy with Improved Formability.

ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy and High Strength Low-Alloy with Improved Formability.

ASTM C840 – Specification for Application and Finishing of Gypsum Board.

ASTM C841 – Specification for Installation of Interior Lathing and Furring.

ASTM C842 – Specification for Application of Interior Gypsum Plaster.

ASTM C926 – Specification for Application of Portland Cement-Based Plaster.

ASTM C954 - Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch (0.8 mm) to 0.112 (2.8 mm) in Thickness.

ASTM C955 – Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners, (Tracks) and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.

ASTM C1007 – Specification for the Installation of Load-Bearing (Transverse and Axial) Steel Studs and Related Accessories.

AWS (American Welding Society) D1.1 – Structural Welding Code – Steel.

AWS D1.3 – Structural Welding Code – Sheet Steel.

DOD (Military Specification) P – 21035A – Print, High Zinc Dust Content, Galvanizing Repair.

ML/SFA 540 (Metal Lath/Steel Framing Association, Division of National Association of Architectural Metal Manufacturers, NAAMM) – Lightweight Steel Framing Systems Manual.

SSPC (Steel Structures Painting Council) Paint No. 15 – Steel Joist Shop Paint Type I, red oxide.

SSPC Paint No. 20 – Zinc Rich Primers, Type I (Inorganic), Type II (Organic).

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Use qualified welders and comply with American Welding Society (AWS) D1.3, “Structural Welding Code – Sheet Steel.” Certify that welders on the work have passed AWS qualification tests for welding processes involved within the previous 12 months or undergone recertification if needed.

1.3.02 Manufacturer Qualifications. Company specializing in manufacturing products specified in this section with minimum of 5 years documented experience.

1.3.03 Installer Qualifications. Company specializing in performing Work of this section with minimum of 5 years documented experience, approved by manufacturer.

Installer shall design structural elements under direct supervision of a Professional Structural or Civil Engineer experienced in design of this Work and licensed in the State of Michigan.

Installer shall form, fabricate, install and connect components in accordance with ML/SFA 540 – Lightweight Steel Framing Systems Manual.

1.3.04 Fire-Rated Assemblies. Where framing units are components of assemblies indicated for a fire-resistance rating, including those required for compliance with governing regulations, provide units that have been approved by governing authorities that have jurisdiction.

1.3.05 Tolerances. Bolt or weld wall panels (at both horizontal and vertical junctures) to produce flush, even, true-to-line joints.

Maximum variation in plane and true position between prefabricated assemblies should not exceed 1/16 inch (1.6 mm).

Vertical alignment (plumbness) of studs shall be within $1/960^{th}$ (1/8 inch (3.2 mm)) in 10 foot (3.1 m) of the span.

Horizontal alignment (levelness) of walls shall be within $1/960^{th}$ (1/8 inch (3.2 mm)) in 10 foot (3.1 m) of their respective lengths.

Spacing of studs shall not be more than 18 inch (45.7 cm) +/- from the designed spacing providing that the cumulative error does not exceed the requirements of the finishing materials.

Prefabricated panels shall be not more than 1/8 inch (3.2 mm) +/- out of square within the length of that panel.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings illustrating materials, shop coatings, steel thickness, details of fabrication, details of attachment to adjoining work, size, location and spacing of fasteners for attaching framing to itself. Details of attachment to the structure, accessories, and their installation and critical installation procedures shall also be included. Drawings may include plans, elevations, sections and details. Indicate component details, framed openings, bearing, anchorage, loading, welds, type and location of fasteners, and accessories or items required of related work. Indicate stud, floor joist, ceiling joist, roof joist, roof rafter, roof truss and layout. Describe method for securing studs to tracks and for bolted, welded framing connections.

Provide calculations for loadings and stresses of specially fabricated framing, roof trusses, under a Professional Engineer's seal.

Submit data on standard framing members. Describe materials and finish, product criteria and limitations. Submit Manufacturer's literature containing product and installation specifications and details for approval.

1.4.02 Certifications. Mill certificates for the steel delivered to the site shall be made available to the Engineer at the time delivery of the steel is made to the job site. Mill certificates shall include as a minimum the steel bare metal thickness in 0.001 inch (0.03 mm), yield strength, tensile strength, total elongation in a 2 inch (5.1 cm) or 8 inch (20.3 cm) gauge length, chemical analysis, and galvanized coating thickness.

Certifications shall be statements from the manufacturer certifying that the materials conform to the appropriate requirements as outlined in the contract documents.

1.4.03 Samples. Submit representative samples of all framing component parts and accessories. Unless otherwise specified, pieces shall be 12 inch (30.5 cm) long and tagged with name of part and manufacturer.

1.5 STORAGE OF MATERIALS. Products shall be protected from conditions that may cause any physical damage. Materials shall be stored on a flat plane. Any damaged materials shall be removed from the job site immediately.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Engineering Calculations or data shall be submitted verifying the framing assembly's ability to meet or exceed design requirements as required by local codes and authorities, or by the Engineer. These calculations shall include, but not be limited to the following items:

> Calculate structural properties of studs and joists in accordance with AISI "Specification for Design of Cold-Formed Steel Structural Members."
>
> Steel Framing used to support rigid materials shall be designed for an

allowable deflection of L/360. Steel framing used to support semi-rigid materials shall be designed for an allowable deflection of L/240.

All connections (member to member, and member to structure), shall be thoroughly examined and designed.

Selected exterior and interior walls, as required, shall be designed to provide frame stability and lateral load resistance. If diagonal steel strapping is used to transfer lateral loads to the structure and foundation, additional studs may be required to resist the vertical component of the load from the diagonal bracing.

Wall bridging shall be designed to provide resistance to minor axis bending and rotation of wall studs.

In accordance with AISI Specifications, rigid collateral facing materials may be considered as adequate support of members against rotation.

2.2 ACCEPTABLE MANUFACTURERS. Subject to compliance with requirements, provide products of one of the following manufacturers or an approved equal.

Alabama Metal Industries Corp.

ClarkDietrich Building Systems LLC

Marino\WARE

Superior Steel Studs, Inc.

USG Industries

United States Steel

2.3 CONSTRUCTION.

2.3.01 System Components. Use manufacturers' standard steel studs and joists of type, size, shape and gage as indicated. With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners and accessories for applications indicated, as needed to provide a complete metal framing system.

2.3.02 Materials and Finishes. For 16 gage (1.6 mm) and heavier units, fabricate metal farming components of structural quality steel sheet with a minimum yield point of 40,000 psi (275.8 MPa); ASTM A653, A1008 or A1011.

For 18 gage (1.3 mm) and lighter units, fabricate metal framing components of commercial quality steel sheet with a minimum yield point of 33,000 psi; (227.5 MPa), ASTM A653, A1008 or A1011.

Provide galvanized finish to metal framing components complying with ASTM A653 for minimum G60 coating. Finish of installation accessories shall match main framing components, unless otherwise indicated.

2.3.03 Fasteners. Provide nuts, bolts, washers, screws and other fasteners with corrosion-resistant plated finish.

2.3.04 Electrodes for Welding. Comply with AWS Code and as recommended by stud manufacturer.

2.3.05 Galvanizing Repair. Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A780.

2.4 MANUFACTURE AND FABRICATION. Fabricate assemblies of formed sections of sizes and profiles required. Fit, reinforce and brace framing members to suit design requirements.

Fit and assemble in largest practical sections for delivery to site, ready for installation. Framing components may be prefabricated into assemblies before erection. Fabricate panels plumb, square, true to line and braced against racking with joints welded. Perform lifting of prefabricated units to prevent damage or distortion. Fabricate units in jig templates to hold members in proper alignment and position and to assure consistent component placement.

2.4.01 Fastenings. Attach similar components by welding. Attach dissimilar components by welding, bolting, or screw fasteners as standard with manufacturer. Wire tying of framing components it not permitted.

2.4.02 Fabrication Tolerances. Fabricate units to a maximum allowable tolerance variation from plumb, level and true to line of 1/8 inch (3.2 mm) in 10 feet (3.1 m).

2.4.03 Shop Painting. All studs, tracks, headers, joists, purlins, bracing, furring, bridging, plates, gussets and clips shall be galvanized to ASTM A123 G90 coating class. Prime paint.

2.5 ACCESSORIES. Use formed sheet steel, thickness determined by performance requirements specified.

Use SSPC Paint 15, Type I, red oxide for in-shop and field touch-up priming. For galvanized surfaces, use SSPC Paint 20, Type I Inorganic, Type II Organic, zinc rich.
2.5.01 Fasteners.

Self-Drilling, Self-Tapping Screws, Bolts, Nuts, and Washers: Provide steel, hot-dip galvanized to ASTM A123, 1.25 ounce per square foot (119.1 grams per sq m).

Anchorage Devices: Use power actuated, drilled expansion bolts, screws with sleeves.

Welding: Shall be in conformance with AWS D1.1 and AWS D1.3.

PART 3 – EXECUTION

3.1 PREPARATION. Prior to start of installation of metal framing systems, conduct Pre-installation conference at project site with installers of other work including door and window frames and mechanical and electrical work. Review areas of potential interference and conflicts and coordinate layout and support provisions for interfacing work.

3.2 INSTALLATION. Install metal framing systems in accordance with manufacturer's printed or written instructions and recommendations. Methods of construction may be either piece by piece (stick-built), or by fabrication into panels either on-or off-site.

Connections shall be accomplished with self-drilling screws or welding so that the connection meets or exceeds the design loads required at that connection.

Transversely loaded studs need not sit squarely in tracks but must be attached to them with the exception of special slip conditions that must be designed accordingly.

Axially loaded studs shall be installed seated squarely (within 1/16 inch (1.6 mm)) against the web portion of the top and bottom tracks. Tracks shall rest on a continuous, uniform bearing surface.

Cutting of steel framing members may be accomplished with a saw or shear. Torch cutting of load bearing members is not permitted. Cutting of loaded members is not permitted unless under supervision of the Engineer.

Temporary bracing shall be provided and left in place until work is permanently stabilized.

Bridging shall be of size and type shown on the drawings and as called for in the design calculations.

Diaphragm rated sheathing materials may be substituted for bridging, however, it shall be installed prior to loading the wall. If such a material is installed on one side of the wall only, then the other stud flanges shall be bridged with suitable bridging. This bridging may be removed if and when such diaphragm rated sheathing is installed.

Install headers in all openings that are larger than the stud spacing in that wall. Form headers as shown on the drawings.

Insulation equal to the job requirements shall be placed in all jamb and header type conditions that will be inaccessible after their installation into the wall.

Provide jack studs to support each end of headers. These studs shall be securely connected to the header and must seat squarely in the lower track of the wall and be properly attached to it.

If by design, a header is low in the wall, the less than full-height studs (cripples) that occur over the header shall be designed to carry all imposed loads.

Wall track shall not be used to support any load unless specifically designed for that purpose.

All axially loaded members shall be aligned vertically, to allow for full transfer of the loads down to the foundation. Vertical alignment shall be maintained at floor/wall intersections or alternate provisions for load transfer may be made.

Holes that are field cut into steel framing members shall be within the limitations of the product and its design. Provide reinforcement where holes are cut through load bearing members in accordance with manufacturer’s recommendations and as approved by the Engineer.

Touch up all steel bared by welding using zinc rich paint.

Studs shall be spaced to suit the design requirements and limitations of collateral facing materials.

Gypsum board shall be attached to steel studs in accordance with ASTM Specification C840, except that the steel drill screws used (Specification ASTM C954) shall be spaced not more than 8 inches (20.3 cm) on center at the edges and ends, and not more than 12 inches (30.5 cm) on center in the field of the board.

Metal plaster bases shall be attached in accordance with ASTM Specification C841, except screw heads shall be of size and type suitable for positive (no movement) attachment.

Care should be taken to allow for additional studs at intersections, corners, doors, windows, control joints, etc., and as called for in the shop drawings or design calculations.

Provision for structure movement (expansion) shall be allowed where indicated and necessary by design or code requirements.

Splicing of axially loaded members shall not be permitted. Wire tying of members is not permitted.

3.2.01 Panelized Construction. Panels shall be designed to resist construction and handling loads as well as live loads.

Handling and lifting of prefabricated panels shall not cause permanent distortion in any member or collateral material.

Make all stud to track connections prior to hoisting of panel.

Where splicing of track is necessary between stud spacings, a piece of stud shall be placed in the track fastened with two screws or welds per flange to each piece of track.

Complete bearing shall be maintained under tracks to provide for load transfer in axially loaded assemblies. If the erecting contractor is bearing on work set by another trade, it is his responsibility to insure that bearing criteria are met. Any discrepancy shall be brought to the attention of the Engineer.

Attachment of the panel to the structure shall be as shown on the shop drawings.

Align all panels to provide continuity of any wall/floor surface.

3.2.02 Runner Tracks. Install continuous tracks sized to match studs. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24 inches (61.0 cm) o.c. spacing for mail or power-driven fasteners or 16 o.c. (40.6 cm) for other types of attachment. Provide fasteners at corners and ends of tracks.

Align track accurately at supporting structure and fasten to structure as shown on shop drawings. Track intersections shall butt evenly. Studs shall be plumbed, aligned and securely attached to flanges or webs of up and lower tracks. Where splicing of track is necessary between stud spacing, a piece of stud shall be placed in the track fastened with two screws or welds per flange to each piece of track.

Complete bearing shall be maintained under tracks to provide for load transfer in axially loaded assemblies. If the erecting contractor is bearing on work set by another trade, it is his responsibility to insure that bearing criteria are met. Any discrepancy shall be brought to the attention of the Engineer prior to the commencement of the work.

3.2.03 Joists. Install level, straight and plumb, complete with bracing and reinforcing as indicated on drawings. Provide not less than 1 1/2 inch (3.8 cm) end bearing. Joist shall be located directly over bearing studs or a load distribution member shall be provided to transfer loads.

Reinforce ends with end clips, steel hangers, steel angle clips, steel stud section or as otherwise recommended by joist manufacturer. Where required, reinforce joists at interior supports with single short length of joist section located directly over interior support, snap-on shoe, 30 percent side-piece lapped reinforcement or other method recommended by joist manufacturer.

Secure joists to interior support systems to prevent lateral movement of bottom flange. Provide web stiffeners where necessary at reaction points and at points of concentrated loads. Joists shall be installed with their web area perpendicular to the bearing surface. Bridging, either steel strap or solid, shall be provided as shown on the shop design calculations.

Provide additional joists under parallel partitions where the partition length exceeds 1/2 of the joist span. Provide additional framing around all floor/roof openings that are larger than the joist spacing. End blocking shall be provided where joist ends are not otherwise restrained from rotation. Joist ends must be built solidly into masonry construction prior to placing any load on the joist.

All bridging, bracing, blocking, strapping, web reinforcement, etc., must be in place prior to loading of floors. If the floor is to be of concrete, care must be exercised in its placement. Care must be taken by all trades not to disturb joist placement, alignment, plumbness, etc., prior to the completion of the floor system. Care must be taken not to overload the floor system during construction. Place heavy loads, materials, equipment, etc., directly over structural supports, bearing walls or as directed by the Engineer.

3.2.04 Fastenings and Attachments. Anchorage of the tracks to the structure shall be with methods designed for that specific application. Size, penetration, type and spacing shall be determined by design.

Welds shall conform to the requirements of AWS E1.3, AWS D1.3, and AISI Manual. Welds may be butt, fillet, spot or groove type, the appropriateness of which shall be determined by and within the design calculations. All welds shall be touched-up using zinc rich paint.

Steel drill screws shall be of the minimum diameter indicated by the design of the particular attachment detail. Penetration through joined materials shall not be less than 3 exposed threads.

Screws shall have a protective coating at least equivalent to zinc plating when used in exterior assemblies.

Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges.

Set studs plumb, except as needed for diagonal bracing or required for non-plumb walls or warped surfaces and similar requirements.

Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

Install supplementary framing, blocking and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim and furnishings, and similar work requiring attachment to the wall or partition. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer’s recommendations and industry standards in each case, considering weight or loading resulting from item supported.

Frame wall openings larger than 2 feet (61.0 cm) square with double stud at each jamb of frame except where more than two are either shown or indicated in manufacturer’s instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding and space jack studs same as full-height studs of wall. Secure stud system wall opening frame in manner indicated.
Frame both sides of expansion and control joints with separate studs. Do not bridge the joint with components of stud system.

Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 48 inches (1.2 m) o.c. Weld at each intersection.

3.2.05 Field Painting. Touch-up damaged shop-applied protective coatings. Use compatible primer for prime-coated surfaces; use galvanizing repair system for galvanized surfaces.

3.3 FIELD QUALITY CONTROL.

3.3.01 Inspections. Inspections by a qualified/independent authority shall be performed in order to assure strict conformance to the shop drawings at all phases of construction. Inspections where and as required by local codes shall be controlled inspections.

All members shall be checked for bearing, completeness of attachments, reinforcement, etc. All attachments shall be checked for conformance with the shop drawings and/or the design calculations. General inspection of structure shall be completed prior to applying loads to those members.

End of Section

SECTION 05500

METAL FABRICATIONS

PART 1 – GENERAL

1.1 SCOPE. Section includes all materials, tools, equipment, apparatus, labor and supervision required to fabricate and furnish all metals to the required dimensions, tolerances and finishes as shown on the drawings.

Fabrication of structural steel consists of manufacturing the parts required to construct the steel frames of buildings and related structures.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements set forth in the current publications and addenda thereto of the following standards:

AA (Aluminum Association) DAF-45 – Designation System for Aluminum Finishes.

AAMA (American Architectural Manufacturers Association) 603.8 9 – Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.

AAMA 605.2 - Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

AAMA 606.1 – Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.

AAMA 607.1 – Specifications and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.

AAMA 608.1- Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum.

ANSI A14.3 - Ladders, Fixed, Safety Requirements.

ASTM (American Society of Testing and Materials) A27/A27M – Specification for Steel Castings, Carbon, for General Application.

ASTM A36/A36M – Specification for Carbon Structural Steel.

ASTM A47/A47M – Specification for Ferritic Malleable Iron Castings.

ASTM A48 – Specification for Gray Iron Castings.

ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

ASTM A123/A123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A143 – Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and procedure for Detecting Embrittement.

ASTM A153/A153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

ASTM A276 – Specification for Stainless Steel Bars and Shapes.

ASTM A283/A283M - Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

ASTM A325 – Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

ASTM A366/A366M – Specification for Commercial Steel Sheet, Carbon, Cold-Rolled.

ASTM A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A501 - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.

ASTM A615/A615M – Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM A786/A786M – Specification for Rolled Steel Floor Plates.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B26/B26M – Specification for Aluminum-Alloy Sand Castings.

ASTM B85 – Specification for Aluminum-Alloy Die Castings.

ASTM B177 – Guide for Chromium Electroplating on Steel for Engineering Use.

ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B210 – Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.

ASTM B211 – Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

ASTM B221 – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

ASTM B316/B316M – Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods.

ASTM B632/B632M – Specification for Aluminum-Alloy Rolled Tread Plate.

AWS (American Welding Society) A2.4 – Symbols for Welding, Brazing, and Nondestructive Examination.

AWS D1.1 – Structural Welding Code-Steel.

AWS D1.2 – Structural Welding Code – Aluminum.

AWS D1.3 – Structural Welding Code – Sheet Steel.

SSPC (Steel Structures Painting Council) – Painting Manual.

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. Qualify welding processes and welding operators in accordance with AWS D1.1 “Structural Welding Code – Steel,” D1.3 “Structural Welding Code – Sheet Steel”, and D1.2 “Structural Welding Code – Aluminum.”

1.3.02 Fabricator Qualifications. Firm shall have five years documented experience in successfully producing and erecting metal fabrications of type indicated for this Project, with sufficient production capacity to produce required units without causing delay in the work.

1.3.03 Installer Qualifications. If possible, Fabricator shall erect metal fabrications. Otherwise, installer shall have five years documented experience in successfully erecting metal fabrications of this type and shall be approved and certified by manufacturer.

1.3.04 Engineer Qualifications. The design Engineer shall be licensed in Michigan and have five years documented experience successfully providing engineering services of the type indicated for this project.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

Where installed, metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified Professional Engineer who was responsible for their preparation.

Submit product data for products used in miscellaneous metal fabrications, including paint products and grout.

1.4.02 Certifications. Welder certificates signed by Contractor certifying that welders comply with requirements specified under “Quality Assurance” article.

Submit certifications for firms and persons specified in “Quality Assurance” article to demonstrate their capabilities and experience. Include list of completed projects with project name, addresses, names of Engineers and Owners, and other information specified.

1.4.03 Samples. Samples representative of materials and finished products as may be requested by Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING. Accept metal fabrications on site in labeled shipments. Inspect for damage. Protect metal fabrications from damage by exposure to weather.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Check actual locations of walls and other construction to which metal fabrications must fit, before fabrication; show recorded field measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

2.2 METALS.

2.2.01 Metal Surfaces. For metal fabrications exposed to view upon completion of the work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.

2.2.02 Steel

Plates, Shapes, and Bars	ASTM A786
Rolled Steel Floor Plates	ASTM A36
Bars for Gratings	ASTM A1011 or ASTM A36

Wire Rod for Grating Cross Bars	ASTM A510
Tubing, Cold-Formed	ASTM A500, Grade A or B as indicated
Tubing, Hot-Formed Steel	ASTM A501
Coatings for Exterior Tubing or as indicated	ASTM A53, hot-dip galvanized coating
Uncoated Structural Sheet, Cold-Rolled	ASTM A1008, Grade A
Uncoated Structural Sheet, Hot-Rolled	ASTM A1011, Grade 30
Uncoated Sheet, Cold-Rolled	ASTM A366
Uncoated Sheet, Hot-Rolled	ASTM A1011
Galvanized Sheet, Structural quality	ASTM A653; Grade A, and G90 coating designation unless otherwise indicated
Galvanized Sheet, Commercial quality	ASTM A653, G90 coating designation unless otherwise indicated
Pipe	ASTM A53. Schedule 40, Type F or S, Grade A or B, black finish unless otherwise indicated. Galvanized finish for exterior installations

2.2.03 Iron.

Gray Iron Castings	ASTM A48, Class 30
Malleable Iron Castings	ASTM A47, Grade 32510

2.2.04 Brackets, Flanges and Anchors. Cast or formed metal of the same type material and finish as supported rails unless otherwise indicated.

2.2.05 Concrete Inserts. Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A47, or cast steel, ASTM A27. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A153.

2.2.06 Welding Rods and Bare Electrodes. Select in accordance with AWS specifications for the metal alloy to be welded.

2.2.07 Stainless Steel.

Bar Stock	ASTM A276, Type 302 or 304
Plate	ASTM A167, Type 302 or 304

2.2.08 Aluminum and Alloys.

Extruded Bars and Shapes	ASTM B221
Bearing Bars of Gratings and Shapes	6061-T6 or 6063-T6
Grating Cross Bars	6061-T1
Rolled Tread Plate	ASTM B632, 6061-T6 for platforms, , 6061-T4 for treads
Rivets	ASTM B316, alloy 6053-T4 or 6061-T6
Sheet for Expanded Aluminum Grating	ASTM B209, alloy 5052-H32
Fasteners for Aluminum Gratings	Use fasteners made of same basic metal as fastened metal except use galvanized fasteners complying with ASTM A153 for exterior aluminum units, unless otherwise indicated. Do not use metals that are corrosive or incompatible with metals joined

2.3 GROUT AND ANCHORING CEMENT.

2.3.01 Nonshrink Metallic Grout. Provide premixed, factory-packaged, ferrous aggregate grout complying with CE CRD-C621, specifically recommended by manufacturer for heavy duty loading applications of type specified in this section.

2.3.02 Interior Anchoring Cement. Provide factory pre-packaged, nonshrink, nonstaining, hydraulic controlled expansion cement formulation for mixing with water at project site to create pourable anchoring patching, and grouting compound. Use for interior applications only.

2.3.03 Erosion-Resistant Anchoring Cement. Provide factory pre-packaged, nonshrink, nonstaining, hydraulic controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without need for protection by a sealer or waterproof coating and is recommended for exterior use by manufacturer.

2.3.04 Acceptable Manufacturers. Subject to compliance with requirements, provide one of the following or an approved equal:

Nonshrink Metallic Grouts:

“Met-Ox Grout”; Chem-Masters Corp.
“NS Metallic Grout”; Euclid Chemical Co.
“Embeco 885”; BASF Corp.

Nonshrink Nonmetallic Grouts:

“Diamond-Crete Grout”; Concrete Service Materials Co.
“Five Star Grout”; Five Star Products
“Kemset”; Chem-Masters Corp.
“Crystex”; L & M Construction Chemicals, Inc.
“Masterflow 713”;BASF Corp.
NS Grout; Euclid Chemical Co.
ProSpec C-1107 Construction Grout; ProSpec
“Vibropruf #11; Lambert Corp.
588-10k Grout; W.R. Meadows

Interior Anchoring Cement:

“Por-Rok”; CGM Inc.
Sakrete Anchor Cement; Sakrete

Erosion-Resistant Anchoring Cement:

“Super Por-Rok”; CGM, Inc.

2.4 FASTENERS. Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.

Bolts and Nuts	ASTM A307, Grade A,

	regular hexagon head type
Lag Bolts	FS FF-B-561, Square head type
Machine Screws	Cadmium plated steel, FS FF-S-92
Wood Screws	FS FF-S-111, Flat head carbon steel
Plain Washers	FS FF-W-92, Round, carbon steel
Drilled-In Expansion Anchors	FS FF-S-325, Group VIII (anchors, expansion, non-drilling, Type I (internally threaded tubular expansion anchor); and machine bolts complying with FS FF-B – 0575, Grade 5
Toggle Bolts	Tumble-wing type, FS FF-B-588
Lock Washers	Helical spring type carbon steel, FS FF-W-84

2.5 PAINTS AND FINISHES.

2.5.01 Shop Primer for Ferrous Metal. Provide manufacturer's or fabricator's standard, fast-curing, lead-free, universal modified alkyd primer selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure complying with performance requirements of FS TT-P-645. Also comply with Master Specification Section 09900, Painting.

2.5.02 Structural Steel Primer Paint. Provide Universal rust-inhibiting primer which can accept epoxy, epoxy esters and phenolic paints as finish coats.

2.5.03 Zinc Chromate Primer. Shall meet FS TT-P-645.

2.5.04 Galvanizing Repair Paint. Provide high zinc dust content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC Paint-20.

2.5.05 Bituminous Paint. Provide cold-applied asphalt mastic complying with SSPC Paint-12 except containing no asbestos fibers.

2.5.06 Shop Coatings Manufacturers. Provide one of the following or an approved equal:

Universal Primer	Carboline Carbogard “888 Primer”, or Tnemec “Series 37H Chem-Prime H.S.”
Red Oxide Primer	SSPC 15, Type 1, or Fed Spec TT-P-636
Epoxy Enamel	Gray; Ameron “Amerlock 400 High-Solids Epoxy Coating”, Carboline “Super Hi-Gard 891”, or Tnemec “Series 140 Pota-Pox Plus”.
Asphalt Varnish	Fed Spec TT-C-494

2.5.07 Galvanizing. All galvanizing shall be done by the hot-dip process after fabrication, in conformity with the requirements of ASTM A123, A153 and A385. Alternatively, blast clean and flux steel. The average minimum thickness of galvanizing shall be 5.0 mils (0.1 mm). The purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed by ASTM A123 and the specified minimum thickness of 5.0 mils (0.1mm) has been met. A report of the test results shall be furnished to the purchaser.

Galvanize bolts, nuts and washers and iron and steel hardware components in accord with ASTM A153. Where galvanized bolts are indicated on the drawings or specified, the use of zinc-plated bolts will not be acceptable.

Safeguard products against steel embrittlement in conformance with ASTM A143. Handle galvanized articles in manner to avoid mechanical damage and to minimize distortion.

2.5.08 Post-Galvanizing Treatments. Shall comply with Master Specification Section 09900, Painting on shop priming and painting. Prepare galvanized metal surfaces to be field painted in accord with paint manufacturer’s recommendations. Shop-coat galvanized metal surfaces with approved primers for galvanized or other approved coatings.

2.6 CONCRETE FILL AND REINFORCING MATERIALS.

2.6.01 Concrete Materials and Properties. Comply with requirements of Master Specification Division 3, Concrete for normal weight, ready-mix concrete with minimum 28-day compressive strength of 2,500 psi (17,237 kPa), 440 lb/ft³ (7,048.2 kg per cu m) cement minimum, and W/C ratio of 0.65 maximum, unless higher strengths indicated.

2.6.02 Nonslip Aggregate Finish. Provide factory-graded, packaged material containing fused aluminum oxide grits or crushed emery as abrasive aggregate; rust-proof and non-glazing unaffected by freezing, moisture, or cleaning materials.

2.6.03 Reinforcing Bars. Shall be ASTM A615, Grade 60, unless otherwise indicated.

2.7 ROUGH HARDWARE. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring and securing woodwork to concrete or other structures.

Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.8 LADDERS.

2.8.01 Steel Ladders. Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.

Siderails shall be continuous steel flat bars, 1/2 inch (1.3 cm) x 2 1/2 inches (6.4 cm), with eased edges, spaced 18 inches (45.7 cm) apart.

Bar Rungs shall be round steel bars, 3/4 inch (1.9 cm) diameter, spaced 12 inches (30.5 cm) o.c.

Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.

Support each ladder at top and bottom and at intermediate points spaced not more than 5'-0" (1.52 m) o.c. by means of welded or bolted steel brackets.

Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches (17.8 cm).

Extend side rails 42 inches (106.7 cm) above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

Provide non-slip surface on top of each rung, either by coating the rung with aluminum oxide granules set in epoxy resin adhesive, or by using a type of manufactured rung which is filled with aluminum oxide grout.

2.8.02 Aluminum Ladders. Fabricate aluminum ladders with rails and rungs for location as shown on the plans.

Ladder shall meet applicable requirements of OSHA, ANSI, State Basic Safety Code, or other regulatory authority.

The rung shall be designed to provide a nonslip power grip surface with a flat 1-inch wide serrated top surface and a semicircular bottom. The straight sides and semicircular bottom shall have striations at approximately 5/16-inch centers for hand grip. The rung shall be an aluminum extrusion, alloy 6063-T6, of sufficient section modulus and moment of inertia to withstand the design loads. Rungs shall have a mill finish.

The side rail shall be 1-1/2-inch Schedule 40 or Schedule 80 aluminum pipe, alloy 6061-T6 or 6105-T5. Pipe shall conform to ASTM B429 or B221 and shall have an anodized finish Aluminum Association AA-M32-C22-A41. Schedule 40 side rails to be attached to supporting vertical surface at a maximum of 6 feet center-to-center. Schedule 80 side rails to be attached at a maximum of 7 feet center-to-center.

Ladder rungs shall be designed to withstand a concentrated load of 250 pounds plus 30 percent impact. Maximum rung deflection shall not exceed L/360. The design load shall be applied at the center of the rung on a 4-inch wide area. Ladders side rails shall be designed to withstand a minimum of two 250-pound loads plus 30 percent impact concentrated between any two consecutive attachments.

Ladder manufacturer to submit test reports to verify that the ladder rung will withstand the specified load within the deflection allowed. The rung to be tested attached to the ladder side rails to simulate actual ladder construction and usage. The load shall be applied and released a minimum of 200,000 times to demonstrate fatigue resistance and a safe extended service life. At completion of testing the rung, attachments and side rails shall be inspected for cracks, looseness, distortion, bending (permanent set), or other obvious defects or damage.

Ladder safety climb devices shall be required at all ladder locations.

Provide stainless steel bolts for ladder attachments.

Welded, pop riveted, or glued construction will not be acceptable for aluminum ladders. Ladders to be shop assembled in as long as practical modules, but not to exceed 24 feet in length.

Unless shown on the plans the Contractor / Fabricator shall design the ladders per latest Michigan building code and meet OSHA (MIOSHA) requirements and submit the shop drawings and calculations for Engineer’s review.

Ladder Safety Post. Equip all ladders installed beneath sidewalk doors, roof hatches, or other floor or roof openings with telescoping tubular safety post, spring balanced and automatically locking in the raised position, with release lever for unlocking, except when ladder is equipped with Safety Climb Device.

Hot-dip galvanized post

Spring Mechanism.

Corrosion-resistant steel alloy.

Manufacturer: Bilco Co., New Haven, CT, Bilco “Ladder Up” Model 2.

2.8.03 Ships Ladders. Provide ship’s ladders where indicated. Fabricate of open type construction with structural steel channel or steel plate stringers, pipe handrails, and open steel grating treads, unless otherwise indicated. Provide all necessary brackets and fittings for installation.

Galvanize ladders, including, brackets and fasteners, in exterior locations and interior locations where indicated.

2.8.04 Ladder Safety Cages. Fabricate ladder safety cages to comply with ANSI A14.3; assemble by welding or riveting.

Primary hoops shall be steel bars, 5/16 inch (7.9 mm) x 4 inches (10.2 cm), for top, bottom, and for cages longer than 20 feet (6.1 m), intermediate hoops spaced not more than 20’-0” (6.1 m) o.c.

Secondary intermediate hoops shall be steel bars, 5/16 inch (7.9 mm) x 2 inches (5.1 cm) hoops spaced not more than 4 feet – 0 inches (1.2 m) o.c. between primary hoops.

Vertical bars shall be steel, 5/16 inch (7.9 mm) x 2 inches (5.1 cm), secured to each hoop, spaced approximately 9 inches (22.9 cm) o.c.

Fasten assembled safety cage to ladder rails and adjacent construction as indicated.

Galvanize ladder safety cages, including fasteners, in exterior locations and interior locations, where indicated.

2.9 NOSINGS. Fabricate curb nosings from structural steel shapes as indicated, of all welded construction with mitered corners and continuously welded joints. Provide anchors welded to nosings for embedding in concrete or masonry construction, spaced not more than 6 inches (15.2 cm) from each curb end, 6 inches (15.2 cm) from corners and 24 inches (61.0 cm) o.c., unless otherwise indicated.

Galvanize nosings in exterior locations and interior locations where indicated.

2.10 LOOSE BEARING AND LEVELING PLATES. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.11 LOOSE STEEL LINTELS. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

Weld adjoining members together to form a single unit where indicated.

Size loose lintels for equal bearing of one inch per foot (8.3 cm per m) of clear span but not less than 8 inches (20.3 cm) bearing at each side of openings, unless otherwise indicated.

Galvanize loose steel lintels located in exterior wall.

2.12 MISCELLANEOUS FRAMING AND SUPPORTS. Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.

Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
Except as otherwise indicated, space anchors 24 inches (61.0 cm) o.c. and provide minimum anchor units in the form of steel straps 1 1/4 inches (3.2 cm) wide x 1/4 inch (6.4 mm) x 8 inches (20.3 cm) long.

Galvanize miscellaneous framing and supports in exterior locations and interior locations where indicated.

2.13 SHELF AND RELIEVING ANGLES. Fabricate shelf and relieving angles from steel angles of sizes indicated and for attachment to concrete framing. Provide slotted holes to receive 3/4 inch (1.9 cm) bolts, spaced not more than 6 inches (15.2 cm) from ends and not more than 24 inches (61.0 cm) o.c. unless otherwise indicated.

For cavity walls, provide vertical channel brackets to support shelf/relieving angles from back-up masonry and concrete. Align expansion joints in angles with indicated expansion joints in cavity wall exterior wythe.

Galvanize shelf angles to be installed on exterior concrete framing.

Furnish wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

2.14 METAL BAR AND EXPANDED METAL BAR GRATINGS. Refer to Master Specification Section 05530, Gratings.

2.15 STEEL PIPE RAILINGS AND HANDRAILS. Refer to Master Specification Section 05520, Handrails and Railings.

2.16 STEEL FRAMED STAIRS. Refer to Master Specification Section 05510, Metal Stairs.

2.17 WHEEL GUARDS. Provide wheel guards of 3/4 inch (1.9 cm) thick, hollow core, gray-iron castings, of size and shape indicated. Provide holes for countersunk anchor bolts and grouting.

2.18 PIPE BOLLARDS. Fabricate pipe bollards from Schedule 80 steel pipe. Cap bollards with 1/4 inch (6.4 mm) minimum thickness steel base plate.

Fabricate sleeves for bollard anchorage from steel pipe with 1/4 inch (6.4 mm) thick steel plate welded to bottom of sleeve.

2.19 FLOOR ACCESS DOORS. Access doors leaf shall be 1/4 inch (6.4 mm) diamond pattern aluminum designed for H-20 loading. The doors shall open and close freely in temperatures ranging from –10 degrees F (-23 degrees C) to 106 degrees F (41 degrees C). The channel frame and door leaf reinforcement shall be not less than 1/4 inch (6.4 mm) aluminum. The frame shall have perimeter anchor flange. Door hardware shall be all stainless steel, compression spring operators with automatic hold-open arm with release handle. A drain shall be provided in the channel frame, piped into the basin. All door surfaces in contact with concrete to be coal tar-epoxied. The schedule of floor access doors on the contract drawings are to be furnished and installed under this section. The door shall be Type J or JD as manufactured by Bilco or approved equal.

2.20 FINISHES. Comply with NAAMM “Metal Finishes Manual” for recommendations relative to application and designations of finishes. Finish metal fabrications after assembly.

2.20.01 Steel and Iron Finishes. For those items indicated for galvanizing, apply zinc-coating by the hot-dip process in compliance with the following requirements:

ASTM A153 for galvanizing iron and steel hardware.

ASTM A123 for galvanizing both fabricated and unfabricated iron and steel products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch (0.8 mm) thick and heavier.

For shop priming, prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

Exteriors (SSPC Zone 1B): SSPC-SP6 “Commercial Blast Cleaning.”

Interiors (SSPC Zone 1A): SSPC-SP3 “Power Tool Cleaning.”

Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finish or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA1 “Paint Application Specification No. 1” for shop painting.

Stripe paint all edges, corners, crevices, bolts, welds, and sharp edges.

2.20.02 Aluminum Finishes. Finish designations prefixed by “AA” shall conform to the system established by the Aluminum Association for designating aluminum finishes.

Fabricated finish shall be AA-M10 (Mechanical Finish: as fabricated, unspecified).

Class I Clear Anodized Finish shall be AA-M12C22A41 (Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class (Architectural: clear film thicker than 0.7 mil (0.02 mm)) complying with AAMA 607.1.

2.21 STEEL PLATFORM. Provide steel platform as shown on the drawings. The platform shall be designed to support the weight and dynamic forces associated with the weight of equipment and associated piping. Join pieces together by welding unless otherwise indicated. Provide complete platform assemblies including metal framing, hangers, columns, struts, clips, brackets, bearing plates and other components necessary for the support of platforms, and as required to anchor and contain the platform on the floor. Note that the grating and handrails are fabricated out of fiberglass.

2.22 TRENCH DRAINS FRAME AND GRATE. Trench drain frame and grate shall be heavy duty, cast iron. Frame and grate shall be coal tar epoxy coated prior to installation.

Trench drains shall be Neenah, R-4990 with Type A grate, EJIW 6900 with Type M2 grate, or approved equal.

Size of trench drain grate shall be as indicated on the drawings.

2.23 CHECKERED PLATE.

2.23.01 Steel. Thickness. As shown, minimum 1/4 inch, meet Federal Specification QQ-F-461, Class I.

Galvanize after fabrication.

2.23.02 Aluminum. Alloy 6061-T6, tread plate, thickness as shown, minimum 1/4 inch.

Fasten accessories by welding or stainless steel bolts or screws.

2.23.03 Stainless Steel. ASTM A167, Type 316, tread plate thickness as shown, minimum 1/4-inch.

2.24 MANUFACTURE AND FABRICATION. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication. Work shall be true to line and level with accurate angles and surfaces and straight sharp edges.

Allow for thermal movement resulting from a maximum change of 100 degrees F (55.5 degrees C) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

Shear and punch metals cleanly and accurately. Remove burrs. Ease exposed edges to a radius of approximately 1/32 inch (0.8 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work. Remove sharp or rough areas on exposed traffic surfaces.

Weld corners and seams continuously to comply with AWS recommendations. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joint where least conspicuous.

Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.

Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

PART 3 – EXECUTION

3.1 PREPARATION. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.2 INSTALLATION.

3.2.01 Sequencing and Scheduling. Sequence and coordinate installation of wall handrails as follows:

Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

Mount handrails only on wall assemblies reinforced to receive anchors, and where the location of concealed anchor plates has been clearly marked for benefit of Installer.

3.2.02 Fastening to In-Place Construction. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

Center nosings on tread widths with noses flush with riser faces and tread surfaces. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2.03 Cutting, Fitting, and Placement. Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rake; and measured from established lines and levels.

Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

3.2.04 Welding. Welding and related operations shall conform to applicable provisions of the Structural Welding Code, AWS D1.1. All welding shall be performed in accordance with written procedures, using only those joint details which have prequalified status when performed in accordance with AWS D1.1. Welding processes shall be limited to those listed in AWS D1.1, Paragraph 1.3.1, except that the short circuiting transfer mode shall not be used. Filler metal shall be of the type listed in AWS D1.1. Connections for structural steel and for stairs shall be made with filler metal having a minimum tensile strength of 70 ksi (482.6 MPa).

Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds. On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces. Leave finish surfaces of members exposed in final structure free of markings, burrs and other defects.

Connections for miscellaneous steel fabrications not included in the AISC definition of structural steel, except stairs, shall be made with filler metal having a minimum tensile strength of 60 ksi (413.7 MPa) or greater.

Welds not dimensioned on the drawings shall be sized to develop the full strength of the least strength component of the connection.

When the steel is to be welded, a welding procedure suitable for the grade of steel and intended use or service shall be utilized. See ASTM A6 for information on weldability.

Where structural or miscellaneous steel connections are welded, all butt and miter welds shall be continuous and, where exposed to view, shall be ground smooth. Intermittent welds shall have an effective length of at least 2 inches (5.1 cm) and shall be spaced not more than 6 inches (15.2 cm) apart.

Stiffener plates shall be tightly fitted to bear against both flanges and web before welding.

3.2.05 Field Welding. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made and methods used in correcting welding work. In addition, use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.

Inspect and test during erection of structural steel. Certify welders and conduct inspections and tests. Record types and locations of defects found in work. Record work required and performed to correct deficiencies. Perform visual inspection of all welds.
Perform tests of welds as follows:

Liquid Penetrant Inspection	ASTM E165
Magnetic Particle Inspection	ASTM E109 performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration not acceptable
Radiographic Inspection	ASTM E94 and ASTM E142; minimum quality level “2-2T”.
Ultrasonic Inspection	ASTM E164

Correct deficiencies in structural steel work which inspections and laboratory test reports show as not in compliance with requirements. Carry out additional tests, at Contractor’s expense, to reconfirm any original work non-compliance and to show corrected work compliance.

3.2.06 Corrosion Protection. Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

3.3 SETTING LOOSE PLATES. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.

Use metallic nonshrink grout in concealed locations where not exposed to moisture; use nonmetallic nonshrink gout in exposed locations, unless otherwise indicated. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLATION OF WHEEL GUARDS. Anchor wheel guards to concrete or masonry construction to comply with manufacturer’s instructions. Fill coarse solidly with air-entrained concrete having a 28-day minimum compressive strength at 3,000 psi (20,684 kPa).

3.5 INSTALLATION OF BOLLARDS. Anchor bollards in concrete by means of pipe sleeves preset and anchored into concrete. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solid with nonshrink, nonmetallic grout, mixed and placed to comply with grout manufacturer’s directions.

3.6 ADJUSTING AND CLEANING. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touch-up of field painted surfaces. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

3.6.01 Touch-Up Painting. Clean and touch-up painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal. Refer to Master Specification Section 09900, Painting.

For galvanized surfaces, clean welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

End of Section

SECTION 05510

METAL STAIRS

PART 1 - GENERAL

1.1 SCOPE. This section includes shop fabricated steel stairs, preassembled stair towers, and integral handrails and balusters. Shop cast concrete treads are also included in this section.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations of the following standards.

ASTM (American Society for Testing and Materials) A36/A36M – Specification for Carbon Structural Steel.

ASTM A53/A53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

ASTM A123/A123M – Specification for Zinc (Hot - Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A153/A153M – Specification for Zinc-Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A283/A283M – Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

ASTM A325 – Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength.

ASTM A500 – Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A501 – Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip process.

ASTM E935 – Test Methods for Performance of Permanent Metal Railing and Systems and Rails for Buildings.

ASTM E985 – Specification for Permanent Metal Railing Systems and Rails for Buildings.

AWS (American Welding Society) A2.0 - Standard Welding Symbols.

AWS D1.1 – Structural Welding Code – Steel

NAAMM (National Association of Architectural Metal Manufacturers) - Metal Stairs Manual.

NAAMM) – Metal Bar Grating Manual.

SSPC – (Steel Structures Painting Council) – Painting Manual.

1.3 QUALITY ASSURANCE. Perform work in accordance with ASTM E985 – Permanent Metal Railing Systems and Rails for Buildings.

Prepare shop drawings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Michigan.

Welders' Certificates: Submit under provisions of this Section, certifying welders employed on Work and verifying AWS qualification within the previous 12 months.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Contractor shall submit shop drawings, indicating profiles, sizes, connection attachments, reinforcing, anchorage, size, type of fasteners, and accessories. Indicate welded connections using standard AWS A2.0 welding symbols. Also, indicate net weld lengths on shop drawing submittals. Submit design calculations with all shop drawing submittals.

1.5 STORAGE OF MATERIALS. Products shall be protected from conditions that may cause any physical damage. Materials shall be stored on a flat plane. Any damaged materials shall be removed from the job site immediately.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.1.01 Structural Design. Stair assembly shall support a uniform live load of 100 pounds, per square foot (12.0 kPa) with deflection of stringer or landing framing not to exceed 1/180 of span. Test in accordance with ASTM E935.

Stair assembly shall also meet NAAMM – Metal Stairs Manual for industrial, commercial and architectural classes of service.

Railing assembly, wall rails, and attachments shall resist a lateral force of 200 pounds at any point without damage. Test in accordance with ASTM E935.

Pipe shall be ASTM A53, Grade B Schedule 40.

Steel Tubing shall be ASTM A500, Grade B.

Sheet Steel shall be galvanized with 0.25 ounce per square foot (76 g per sq m) galvanized coating in accordance with ASTM A653.

2.1.02 Tread and Landing Concrete Reinforcement. Mesh or Bar type as detailed, galvanized or unfinished.

2.1.03 Bolts, Nuts, and Washers. ASTM A325 or A307 galvanized to ASTM A153 for galvanized components.

2.1.04 Exposed Mechanical Fastenings. Flush countersunk screws or bolts, consistent with design of stair structure.

2.1.05 Welding Materials. Materials shall meet AWS D1.1 for type of materials being welded.

2.1.06 Shop and Touch-Up Primer. Primer used for shop primer painting and field touch-up priming shall be SSPC No.15, Type 1, red oxide.

2.1.07 Touch-up Primer for Galvanized Surfaces. Primer shall be SSPC No. 20 Type I Inorganic or Type II Organic zinc rich.

2.1.08 Gratings. Gratings shall be per NAAMM, Metal Bar Grating Manual, welded or pressure locked type.

2.1.09 Plastic Handrail Cover. Use extruded PVC for cover.

2.1.10 Infill Panels. Panels shall be tempered glass, polycarbonate or acrylic clear panels.

2.1.11 Stair Treads. Shop cast concrete in metal pan shall have rough surface with a non-slip edge.

2.1.12 Shop Cast Concrete Treads. Width shall be as detailed with no bar reinforcement, rough finish and radiused nosings.

2.1.13 Concrete. Type shall be as specified in Master Specification Section 03300, Cast-in-Place.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers include Chicago Ornamental Iron Co., Lapeyre Stair Model, The Sharon Co., Inc., Summit Steel Fabricators, Inc., or an approved equal.

2.3 MANUFACTURE AND FABRICATION. Fit and shop assemble components in largest practical sections, for delivery to site. Fabricate components with joints tightly fitted and secured. Continuously seal joined pieces by continuous welds.

Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

Exposed mechanical fastenings shall be flush countersunk screws or bolts, unobtrusively located; consistent with design of component, except where specifically noted otherwise.

Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish throughout, except where specifically noted otherwise.

Accurately form components required for anchorage of stairs, landings and railings to each other or to building structure.

2.3.01 Surface Preparation. After inspection and before shipping, clean steel stair components to be painted. Remove loose rust, loose mill scale, splatter, slag or flux deposits. Clean steel in accord with procedures defined in SSPC-SP/10, “Neon White Blast Cleaning.”

2.3.02 Steel Framed Stairs. Construct stairs to conform to sizes and arrangements indicated. Join pieces together by welding, unless otherwise indicated. Provide complete stair assemblies, including metal framing, hangers, columns, railings, newels, balusters, struts, clips, brackets, bearing plates, and other components necessary for the support of stairs and platforms, and as required to anchor and contain the stairs on the supporting structure.

Comply with “Recommended Voluntary Minimum Standards for Fixed Metal Stairs” in NAAMM “Metal Stair Manual” for class of stair designated, except where more stringent requirements are indicated. Use Commercial class, unless otherwise indicated.

Fabricate treads and platforms of exterior stairs to accommodate slopes to drain in finished traffic surfaces.

2.3.03 Stair Framing. Fabricate stringers of structural steel channels, or plates, or a combination thereof, as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to strings, newels, and framing members to strings and headers; fabricate and join so that bolts, if used, do not appear on finish surfaces.

Where masonry walls support steel stairs, provide temporary supporting struts designed for erection of steel stair components before installation of masonry.

Attach risers and subtreads to stringers by means of brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting or bolting.

2.3.04 Stair Treads and Platforms. Stair and landings can be pre-fabricated or erected at the job site.
2.3.05 Pan Stairs and Landings. Pan stairs and landings can be prefabricated and pre-poured or erected and poured at the job site.

Prefabricated stair assemblies with pre-filled treads consisting of pre-poured reinforced concrete fill shall be manufactured with non-slip aggregate finish, in welded sheet metal pan, and attached to installed stringers using manufacturer’s standard connection detail. Provide sub-platforms of configuration and construction indicated; or if not indicated, of same metal as risers and sub-treads, in thicknesses required to support design loading. Attach sub-platform to platform framing members with welds. Construct sub-platforms with smooth soffits. Subject to compliance with requirements, provide Speedstair by American Stair Corp, Inc, or an approved equal

If field poured, fabricate stairs and landings with closed or open risers and treads of metal pan construction, ready to receive concrete. Form treads and risers with minimum 14 gage (2.0 mm) thick which are sheet steel stock. Secure reinforced tread pans to stringers with clip angles, welded or bolted in place.

Form stringers shall be rolled steel channels 12 inches (30.5 cm) deep. Weld fascia plates to channels using 14 gage (2.0 mm) thick steel sheet across channel toes. Form landings with minimum 14 gage (2.0 mm) thick sheet stock. Reinforce underside with angles to attain design load requirements. Form balusters with 1 1/2 (3.8 cm) inch diameter steel sections, welded to stringers.

2.3.06 Checkered Plate Stairs and Landings. For raised steel floor plate treads and platforms, provide plate in pattern indicated or, if not indicated, as selected from manufacturer's standard patterns. Form treads of 1/4 inch (6.4 mm) thick raised pattern steel floor plate with integral nosing and back edge stiffener. Weld steel supporting brackets to stringers and treads to brackets. Use steel plates with prime paint galvanized finish. Fabricate platforms of raised pattern steel floor plate of thickness indicated. Provide nosing matching that on treads at all landings. Secure to platform framing members with welds.

Form stringers with rolled steel channels 12 inches (30.5 cm) deep with a prime paint or galvanized finish. Form landings with checkered steel plate with a prime paint or galvanized finish. Reinforce underside with angles to attain design load requirements. Form balusters with 1 1/2 inch (3.8 cm) diameter steel sections, welded to stringers with a prime paint or galvanized finish.

2.3.07 Open Grating Stairs and Landings. For floor grating treads and platforms, provide patterns, spacing, and bar sizes indicated; fabricate to comply with NAAMM "Metal Bar Grating Manual." Use steel bars welded or bolted to supports with a prime paint or galvanized finish. Fabricate grating treads with steel plate nosing on one edge and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts. Fabricate grating platforms, with nosing matching that on grating treads, at all landings. Provide toe plates at open-sided edges of grating platform. Secure steel grating to platform frame with welds and aluminum grating to platform frame with saddle clips. Finish shall be shop applied primer and shop- or field-applied paint, as indicated. Also refer to and comply with Master Specification Section 05530, Gratings.

Form hollow stringers with rolled steel channels with a prime paint or galvanized finish. Form landings in accordance with ANSI A202.1 same as treads with a prime paint or galvanized finish. Reinforce underside with angles to attain design load requirements. Form balusters with 1 1/2 inch (3.8 cm) diameter steel sections welded to stringers with a prime paint or galvanized finish.

2.3.08 Unit Stair Towers. Fabricate self-supporting steel stair towers with formed treads and risers. Utilize steel channel stringers and landing platforms. Corner structural support members shall be designed to support full weight of complete stair tower plus design live load; with steel railings, newel posts, and balusters. All units shall be sectored for transport.

2.3.09 Handrails and Railings. Fabricate newels of steel tubing and provide newel caps of gray-iron castings, as shown. Railings may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings. Connect railing posts to stair framing by direct welding, unless otherwise indicated. Also refer to and comply with applicable requirements specified in Master Specification Section 05520, Handrails and Railings.

2.4 SHOP FINISHING. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing. Do not prime surfaces in direct contact with concrete or where field welding is required. Prime paint items with two coats. Galvanize items to minimum 1.25 ounces per square foot (381 g per square meter) zinc coating in accordance with ASTM A123.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that field conditions are acceptable and are ready to receive work. Verify concealed blocking and reinforcement is installed and correctly located to receive wall mounted handrails.

3.2 PREPARATION. Clean and strip primed steel items to bare metal where site welding is required. Supply items required to be cast into concrete and or embedded in masonry with setting templates.

3.3 INSTALLATION. Convene minimum of one week prior to commencing work of this section. Install components plumb and level, accurately fitted and free from distortion or defects. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure. Provide sufficient temporary bracing to maintain true alignment of erected loads until completion of erection and installation of permanent attachments.

Field weld components indicated on shop drawings. Perform field welding in accordance with AWS D1.1. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

Obtain approval prior to site cutting or creating adjustments not scheduled.

Prime welds, abrasions, and surfaces not shop primed after erection and galvanized surfaces indicated to receive field coats, except when surfaces are to be in contact with concrete.

End of Section

SECTION 05520

HANDRAILS AND RAILINGS

PART 1 – GENERAL

1.1 SCOPE. Section includes carbon steel, stainless steel, aluminum or polyvinyl chloride pipe, tube railings, balusters, fittings, handrails and plastic covered handrails.

1.2 GENERAL.

1.2.01 Coordination. Prior to the beginning of work, conduct a pre-installation conference at the job site. Provide seven calendar days advance written notice ensuring the attendance by competent authorized representatives of the fabricator, building owner’s representative, Engineer, and subcontractors whose work interfaces with the work of this Section. Review the specifications to determine any potential problems, changes, scheduling, unique job site conditions, installation requirements and procedures and any other information pertinent to the installation. Record the results of the conference and furnish copies to all participants.

1.2.02 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

AAMA (American Aluminum Manufacturer’s Association) 603.8 - Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.

AAMA 605.2 - Voluntary Specification for High Performance Organic Coatings on Engineerural Extrusions and Panels.

AAMA 606.1 - Voluntary Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Engineerural Aluminum.

AAMA 607.1 - Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Engineerural Aluminum.

AAMA 608.1 - Voluntary Guide Specification and Inspection Methods for Electrolytically Deposited Anodic Finishes for Engineerural Aluminum.

ASTM (American Society of Testing and Materials) A53/A53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

ASTM A123/A123M - Specification for Pipe Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A500 - Specification for Pipe Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A501- Specification for Pipe Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

ASTM B177 – Guide for Chromium Electroplating on Steel for Engineering Use.

ASTM B211 - Specification for Pipe Aluminum and Aluminum-Alloy Bar, Rod, and Wire, Profiles, and Tubes.

ASTM B221 - Specification for Pipe Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

ASTM B241/B241M - Specification for Pipe Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

ASTM B483/B483M – Specification for Pipe Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.

ASTM E935 - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.

ASTM E985 – Specification for Pipe Permanent Metal Railing Systems and Rails for Buildings.

SSPC (Steel Structures Painting Council) – Painting Manual.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Contractor shall have 5 years documented experience in this specialty and shall furnish references listing projects of similar size and scope.

1.3.02 Regulatory Requirements. Components and installation are to be in compliance with state and local code authorities. Components and installation are to follow current ADA and CABO/ANSI guidelines.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings that indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories. Submit manufacturer's data on each product.

1.4.02 Certifications. Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer. Furnish certification that components were installed in accordance to manufacturer's engineering data to meet the specified design loads.

1.4.03 Samples. Submit two samples of handrails, elbow, tee, wall bracket, and end stop.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.

Store material on site in a location and in a manner to avoid damage. Stack in a way to prevent bending. Store material in a clean, dry location away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Handrail assemblies and attachments shall withstand a minimum concentration of 200 pounds (90.7 kg) applied in any direction at any point along the top.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers include Blumcraft of Pittsburgh, Hollaender Manufacturing Company, Superior Aluminum Products, Inc., Julius Blum & Company, Inc., or an approved equal.

2.3 ALUMINUM RAILING SYSTEM COMPONENTS.

2.3.01 Rails and Posts. Extruded tubing conforming to ASTM B221 or B483.

2.3.02 Fittings. Elbows, T-shapes, wall brackets, escutcheons; cast or machined aluminum.

2.3.03 Mounting. Adjustable brackets and flanges, with aluminum inserts for casting in concrete or with aluminum brackets for embedding into masonry. Prepare backing plate for mounting in masonry wall construction.

2.3.04 Splice Connectors. Concealed spigot or collar with locking set screws or welding collars; cast or machined aluminum.

2.3.05 Exposed Fasteners. Flush countersunk screws or bolts consistent with design of railings. Finish coatings shall conform to AAMA 606.1, 607.1, 608.1.

2.3.06 Exterior Aluminum Surfaces. AAMA A42 or A44 anodized, prepared with a mechanical or chemical pre-treatment, anodized to a clear color.

2.4 STEEL RAILING SYSTEM COMPONENTS.

2.4.01 Steel Tubing. ASTM A500, Grade B.

2.4.02 Fittings. Elbows, T-shapes, wall brackets, escutcheons; cast or machined steel.

2.4.03 Mounting. Adjustable brackets and flanges, steel inserts for casting in concrete or with steel brackets for embedding in masonry. Prepare backing plate for mounting in masonry wall construction.

2.4.04 Exposed Fasteners. Flush countersunk screws or bolts consistent with design of railing.

2.4.05 Splice Connectors. Steel concealed spigots or welding collars or threaded collars.

2.4.06 Plastic Handrail Cover. Extruded PVC, profile and color as selected.

2.4.07 Pipe. ASTM A53, Grade B Schedule 40.

2.5 STEEL PIPE RAIL AND HANDRAILS. Fabricate pipe railings and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.

Interconnect railing and handrail members by butt-welding or welding with internal connectors, at fabricator’s option, unless otherwise indicated.

At tee and cross intersections, notch ends of intersecting members to fit contour of pipe to which end is joined and weld all around.

Form changes in direction of railing members by insertion of prefabricated elbow fittings, radius bends of radius indicated, mitering at elbow bends, or bending, as applicable for the change of direction involved.

Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.

Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.

Close exposed ends of pipe by welding 3/16 inch (4.8 mm) thick steel plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is 1/4 inch (6.4 mm) or less.

2.5.01 <u>Toe Boards</u>. Where indicated, provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated, or if not indicated, use 4 inch (10.2 cm) high x 1/8 inch (3.2 mm) steel plate centered between and welded to each railing post.

2.5.02 <u>Brackets, Flanges, Fittings, and Anchors</u>. Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.

For railing posts set in concrete fabricate sleeves from steel pipe not less than 6 inches (15.2 cm) long and with an inside diameter not less than 1/2 inch (1.3 cm) greater than the outside diameter of post, with steel plate closure welded to bottom of sleeve.

Provide friction fit, removable covers designed to keep sleeves clean and hold top edge of sleeve 1/2 inch (1.3 cm) below finished surface of concrete.

For removable railing posts, fabricate slip-fit sockets from steel pipe whose inside diameter is sized for a close fit with posts and to limit deflection of post without lateral load, measured at top, to not more than 1/12 of post height. Provide socket covers designed and fabricated to resist accidental dislodgement.

2.5.03 <u>Fillers</u>. Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses. Size fillers to produce adequate bearing to prevent bracket rotation and overstressing of substrate.

For exterior steel railings and handrails formed from steel pipe with galvanized finish, galvanize all fittings, brackets, fasteners, sleeves, and other ferrous components.

For interior steel railings and handrails formed from steel pipe with galvanized finish, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

For interior steel railings formed from steel pipe with black finish, provide nongalvanized ferrous metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

2.6 MANUFACTURE AND FABRICATION. Verify field measurements prior to fabrication. Fit and shop assemble components in largest practical sizes for delivery to site. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

2.6.01 Exposed Mechanical Fastenings. Flush countersunk screws or bolts, unobtrusively located, consistent with design of component, except where specifically noted otherwise.

Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.6.02 Exterior Components. Continuously seal joined pieces by continuous welds. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush and hairline. Ease exposed edges to small uniform radius. Accurately form components to suit stairs and landings, connected to each other and to building structure.

Accommodate for expansion and contraction of members and building movement without damage to connections or members.

PART 3 – EXECUTION

3.1 INSPECTION. Verify that field conditions are acceptable and are ready to receive work. Verify concealed blocking and reinforcement is installed and correctly located to receive wall mounted handrails.

3.2 PREPARATION. Clean and strip primed steel items to bare metal where site welding is required.

Supply items required to be encased into concrete and or embedded in masonry placed in partitions with setting templates to appropriate sections.

3.3 INSTALLATION. Install in accordance with shop drawings and manufacturer's instructions. Install components plumb and level, accurately fitted, free from defects or distortion detrimental to appearance.

3.3.01 Hand Railings. Anchor railings to structure with anchors bolts, plates, or angles.

If welding, field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.

If using bolts and screws, conceal whenever possible. Where not concealed, use flush countersunk fastenings.

Assemble with spigots and sleeves to accommodate tight joints and secure installation.

3.3.02 Steel Pipe Railings. Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required for design loads. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:

Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with anchoring material, mixed and placed to comply with anchoring material manufacturer's directions.

If preset pipe sleeves are not indicated, anchor posts in concrete by core drilling holes not less than 5 inches (12.7 cm) deep and 3/4 inch (1.9 cm) greater than outside diameter of post. Clean holes of all loose material, insert posts and fill annular space between post and concrete with non-shrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's directions.

For interior applications or as indicated, cover anchorage joint with a round steel flange either Welded to post after placement of anchoring material or attached by set screws.

For exterior applications or as indicated, leave anchorage joint exposed, wipe off surplus anchoring material, and leave 1/8 inch (3.2 mm) build-up, sloped away from post. For installations exposed on exterior, or to flow of water, seal anchoring material to comply with grout manufacturer's directions.

Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to steel supporting members.

Anchor rail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into wall construction with lead expansion shields and bolts.

Anchor rail ends to steel with steel oval or round flanges welded to rail ends and bolted to structural steel members, unless otherwise indicated.

Install removable railing sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.

Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1 1/2 inch (3.8 cm) clearance from inside face of handrail and finished wall surface. Locate brackets as indicated, or if not indicated, at spacing required to support structural loads. Secure wall brackets and wall return fittings to building construction using either a bracket with flange tapped for concealed anchorage to threaded hanger bolt or a bracket with pre-drilled hole for exposed bolt anchorage, as indicated. For concrete and solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable. For hollow masonry anchorage, use toggle bolts having square heads. For steel framed gypsum board assemblies, fasten brackets directly to steel framing or concealed anchors using self-tapping screws of size and type required to support structural loads.

3.3.03 Expansion Joints. Provide expansion joints as needed to allow for thermal expansion. Provide along pipe and hand railings at locations indicated, or if not indicated, at intervals not to exceed 40 feet (12.2 m). Provide slip joint with internal sleeve extending 2 inches (5.1 cm) beyond joint on either side; fasten internal sleeve securely to one side; locate joint within 6 inches (15.2 cm) of posts.

3.3.04 Cleaning. After installation is completed, wash thoroughly using clean water and soap and rinse with clean water. Do not use acid solution, steel wool or other harsh abrasives. If stain remains after washing, remove finish and restore in accordance with NAAMM Metal Finishes Manual.

Finish must not be removed from anodized aluminum. If aluminum finish is damaged, return component to anodizer for re-anodizing.

3.4 FIELD QUALITY CONTROL. Remove stained or otherwise defective work and replace with material that meets specification requirements.

End of Section

SECTION 05530

GRATINGS

PART 1 – GENERAL

1.1 SCOPE. This section includes metal bar gratings and floor plates. These items, usually supporting pedestrian or light vehicle loads, are either custom fabricated or of proprietary manufacturer. Support framing for formed openings is included in this section.

1.2 GENERAL.

1.2.01 Governing Standards. Comply with the requirements and recommendations of the following standards:

ASTM (American Society for Testing and Materials) A36/A36M – Specification for Pipe Carbon Structural Steel.

ASTM A123/A123M – Specification for Pipe Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A653/A653M – Specification for Pipe Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A666 – Specification for Pipe Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B211 – Specification for Pipe Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

ASTM B221 – Specification for Pipe Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

ASTM B633 – Specification for Electrodeposited Coatings of Zinc or Iron and

Steel.

AWS (American Welding Society) D2.0 – Standard Welding Symbols.

AWS D1.2 - Structural Welding Code – Aluminum.

AWS D1.3 – Structural Welding Code – Sheet Steel.

AWS D1.1 – Structural Welding Code – Steel

NAAMM (National Association of Architectural Metal Manufacturers) – Metal Bar Grating Manual.

NAAMM - Heavy Duty Metal Bare Grating Manual.

SSPC (Steel Structures Painting Council) – Painting Manual.

1.3 QUALITY ASSURANCE.

1.3.01 Fabricator Qualifications. A firm experienced in producing gratings similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

Design gratings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Michigan.

1.3.02 Metal Bar Grating Standards. Comply with applicable requirements of the following:

ASTM B221, "Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes."

Non-Heavy-Duty Metal Bar Gratings: Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads.

Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 532, Heavy-Duty Metal Bar Grating Manual.

1.3.03 Welding. Qualify procedures and personnel according to the following:

AWS D1.1, Structural Welding Code – Steel.

AWS D1.2, Structural Welding Code – Aluminum.

AWS D1.3, Structural Welding Code – Sheet Steel.

Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

Take field measurements prior to preparation of shop drawings and fabrication where required, to ensure proper fitting of the work.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Show fabrication and installation details for gratings. Include plans, elevations, sections, and details of connections. Show anchorage, accessory items while providing templates for anchors and bolts specified for installation under other sections. Shop drawings shall show the dimensions and placement of grating panels including grating clips and fastener details. The submittal shall contain coordination with equipment suppliers where openings for equipment are required. Submit manufacturer's specifications, load tables, anchor details and standard installation details.

Submit computations or load tables to show that the grating can support 150 psf (7.2 kPa) live load with no more than 1/4 inch (6.4 mm) deflection.

Provide documentation for clips and anchorage devices for gratings and paint products.

1.4.02. Certifications. Submit certifications for welders employed on the Work verifying they have met AWS qualifications within the previous 12 months.

1.4.03 Samples. Provide samples of each type of grating for approval by Engineer prior to fabrication. Samples shall include main support member, tie members, and banding. Submit samples of materials proposed for use, where required for testing.

1.5 DELIVERY, STORAGE AND HANDLING. For long term storage, store grating on pallets, Keep all FRP materials covered. Do not drag panels across one another. Seal any scratches, crushed or chipped edges.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.1.01 General. All grating and grating stair treads shall be aluminum or steel as indicated on the drawings. Depth of bearing bars for grating and treads shall be as indicated on the drawings.

Except as modified herein, the manufacture, fabrication, and installation of grating shall comply with recommendations in the “Metal Bar Grating Manual” of the National Association of Architectural Metal Manufacturers.

2.1.02 Structural Performance. Provide gratings capable of withstanding structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections.

2.1.03 Floors. Capable of withstanding a uniform load of 260 lbf per square foot (12.4 kPa) or a concentrated load of 3000 lbf (1360.8 kg) whichever produces the greater stress.

2.1.04 Walkways and Elevated Platforms. Capable of withstanding a uniform load of 60 lbf per square foot (2.9 kPa). Limit deflection to L/360 or 1/4 inch (6.4 mm) whichever is less.

2.1.05 Walkways and Elevated Platforms. Capable of withstanding a uniform load of 100 lbf per square foot (4.8 kPa) or a concentrated load of 300 lbf (136.1 kg) on an area of 4 square inch (25.8 sq cm) whichever produces the greater stress. Limit deflection to L/360 or 1/4 inch (6.4 mm), whichever is less.

2.1.06 Sidewalks and Vehicular Driveways. Capable of withstanding a uniform load of 250 lbf per square foot (12.0 kPa) or a concentrated load of 8000 lbf (3628.8 kg), whichever produces the greater stress.

2.2 ACCEPTABLE MANUFACTURERS. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

Metal Bar Gratings:

All American Grating, Inc.

Barnett/Bates Corp.

Harsco IKG.

Ohio Gratings, Inc.

Seidelhuber Metal Products, Inc.

Tru-Weld Grating, Inc.

Or Equal

2.3 MATERIALS.

2.3.01 Aluminum. Extruded bars and shapes shall comply with ASTM B221, alloys as follows:

6061-T6 or 6063-T6 – for bearing bars of gratings and shapes.

6061-T1 – for grating crossbars.

Aluminum Sheet shall comply with ASTM B209 alloy 5052-H32.

Aluminum grating shall be the mechanically locked type, with cross bars deformed or swaged to prevent turning. Grating stair treads shall be pressure locked or one-piece cast or extruded type. Bearing bars shall be at least 3/16 inch (4.8 mm) thick flat stock or equivalent I-bars, with center-to-center spacing of 1 3/16 inches (3.0 cm).

2.3.02 Steel Grating. Steel grating shall be welded type. Bearing bars shall be at least 3/16 inch (4.8 mm) thick, with center-to-center spacing of 1 3/16 (3.0 cm) inches. Grating shall be galvanized after fabrication. Bearing and cross bars shall be flush at surface. Provide nonslip surface.

2.3.03 Paint. Prepare surfaces to be primed in accordance with SSPC SP 2. Cold-applied asphalt mastic paint shall comply with SSPC Paint No. 12, except containing no asbestos fibers, or cold-applied asphalt emulsion per ASTM D1187.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 General. Grating panels shall be arranged so that openings are centered on a joint between panels. Toeplates extending the full depth of the grating and 4 inches (10.2 cm) above the top shall be provided around openings 2 inches (5.1 cm) and greater in diameter and on the open sides of stairway landings, overhead platforms, overhead walkways, and other locations indicated on the drawings. Ends of bearing bars in grating floor panels shall be provided with full-depth bands. Bands and toeplates shall be 3/16 inch (4.8 mm) thick. Toeplates shall be welded to each bearing bar. Bands shall be welded to the first, the last, and every fourth intermediate bar. Cross bars shall be cut off flush with the outside face of side bars.

All angular, circular, re-entrant, and other cuts in aluminum grating shall be sawed or sheared. Angular, circular and re-entrant cuts in steel grating may be made by flame cutting. All other cuts in steel grating shall be sawed or sheared. Cuts shall be smooth and clean, without fins, beads or other projections. Provide cut outs as required for the passage of pipes, valves and equipment operators, conduit, stems, and similar work. Cut outs for circular obstructions shall be at least 2 inches (5.1 cm) larger in diameter than the obstruction.

Grating shall be fabricated in panels that can be easily handled by plant personnel. Unless otherwise indicated on the drawings, the weight of individual panels shall not exceed 150 pounds (68.0 kg). Panels shall be within ± 3/16 inch (4.8 mm) of authorized length and ± 1/8 inch (3.2 mm) of authorized width, and shall have a maximum difference in length of opposite diagonals of 1/4 inch (6.4 mm). The spacing of bearing bars shall be within 1/32 inch (0.8 mm) of authorized spacing.

Cross bars and edge bars of adjacent panels shall align. After installation, there shall be not more than 1/4 inch (6.4 mm) clearance between panels. All bearing bars shall be parallel. Bands and toeplates shall align within 1/8 inch (3.2 mm) tolerance, vertical and horizontal.

All grating shall lie flat, with no tendency to rock when installed without the use of wedges or shims. Poorly fitting or damaged grating will be rejected.

Steel frames anchored to or cast in concrete to support grating shall be hot-dip galvanized after fabrication.

Provide removable sections of grating with suitable end bearing where noted on the drawings or otherwise required.

Grating stair treads shall be provided with carrier plats and Wooster “120” abrasive nosings. Stair treads shall be fastened to stair stringers with galvanized bolts. Nosings shall be attached with stainless steel bolts and self-locking nuts.

2.4.02 Shop Assembly. Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

Shear and punch metals clearly and accurately. Remove any burrs on grating.

Ease exposed edges to a radius of approximately 1/32 inch (0.8 mm), unless otherwise indicated.

Fit exposed connections accurately together to form hairline joints.

2.4.03 Welding. Comply with AWS recommendations. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately.

Provide for anchorage of type indicated and coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

Fabricate toeplates for attaching in the field. Toeplate Height shall be 4 inches, (10.2 cm) unless otherwise indicated.

2.5 METAL BAR GRATINGS. Produce metal bar gratings of description indicated per NAAMM marking system that comply with the following:

Metal Bar Grating Standard "Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads" published in ANSI/NAAMM A202.2 "Metal Bar Grating Manual."

Heavy Duty Metal Bar Grating Standard: "Guide Specifications for Heavy Duty Metal Bar Grating" published in NAAMM "Heavy Duty Metal Bar Grating Manual."

2.5.01 Welded and Pressure-Locked Steel Gratings. Mark/Size shall be W-15-4 (welded with bearing bars 15/16 inch (2.4 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), W-19-4 (welded with bearings bars 1 3/16 inch (3.0 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), or as indicated with bearing bar sizes as indicated.

2.5.02 Riveted Steel Gratings. Mark/Size shall be R-12-7 (riveted with 3/4 inch (1.9 cm) space between bearing bars and cross bars 7 inches (17.8 cm) o.c.), R-18-7 (riveted with 1 1/8 inch (2.9 cm) space between bearing bars and cross bars 4 inches (10.2 cm) o.c.), or as indicated with bearing bar sizes as indicated.

2.5.03 Pressure-Locked Rectangular Bar Aluminum Gratings. Mark/Size shall be P-7-4 (pressure-locked with bearing bars 7/16 inch (1.1 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), P-15-4 (pressure-locked with bearing bars 15/16 inch (2.4 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), P-19-4 (pressure-locked with bearing bars 1 3/16 inches (3.0 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), or as indicated with rectangular bearing bar sizes as indicated.

2.5.04 Pressure-Locked I-Bar Aluminum Gratings. Mark/Size shall be P-16-2 (pressure-locked with bearing bars 1 inch (2.5 cm) o.c. and cross bar 2 inches (5.1 cm) o.c.), P-19-4 (pressure-locked with bearing bars 1 3/16 inch (3.0 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), or as indicated with I-shaped bearing bar sizes as indicated.

2.5.05 Welded Heavy Duty Steel Gratings. Mark/Size shall be W-19-4 (welded with bearing bars 1 3/16 inch (3.0 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), W-30-4 (welded with bearing bars 1 7/8 inch (4.8 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.), or as indicated with bearing bar sizes as indicated. Grating will be sized to comply with structural performance requirements.

2.5.06 Pressure-Locked, Heavy Duty Stainless Steel Gratings. Mark/Size shall be P-38-4 (riveted with bearing bars spaced 2 3/8 inches (6.0 cm) o.c. and cross bars 4 inches (10.2 cm) o.c.) or as indicated with bearing bar sizes as indicated. Grating will be sized to comply with structural performance requirements.

2.5.07 Riveted Heavy Duty Steel Gratings. Mark/Size shall be R-19-3-1/2 (riveted with 1 3/16 inch (3.0 cm) space between bearing bars and cross bars 3 1/2 inches (8.9 cm) o.c.) or as indicated with bearing bar sizes as indicated. Grating will be sized to comply with structural performance requirements.

2.5.08 Traffic Surface for Steel Bar Gratings. Traffic surfaces shall be plain, serrated, knurled, applied abrasive finish (consisting of aluminum oxide aggregate in an epoxy resin adhesive), or as indicated.

2.5.09 Traffic Surface for Aluminum Bar Gratings. Traffic surfaces shall be plain, grooved, applied abrasive finish (consisting of aluminum oxide aggregate in an epoxy resin adhesive), or as indicated.

2.5.10 Steel Finish. For interior finishes or as indicated, apply prime paint in shop in accordance with manufacturer’s standard practice.

For exterior finishes or as indicated, apply hot-dip galvanized with a coating weight of not less than 1.8 ounce per square foot (549 g per sq m) of coated surface.

2.5.11 Aluminum Finish. Provide Mill or Class I Clear anodized finish as indicated.

Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated, or if not indicated, as recommended by manufacturer, for attachment to supports.

Provide grating panels in 6 feet – 0 inches (1.8 m) maximum widths.

Provide 12 inch (30.5 cm) wide banded panels at all stop gate locations.

Provide not less than 4 anchor blocks for each section of heavy duty grating composed of bearing bars over 3/16 inch (4.8 mm) in thickness, with each block shop-welded to 2 bearing bars.

Provide not less than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced 15/16 inch (2.4 cm) or more o.c. Each clip shall be designed and fabricated to fit over two bearing bars. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.

Subject to compliance with requirements, a product that may be incorporated into the work includes, but is not limited to, “Grate-Fast” by Struct-Fast Inc.

Provide not less than 4 flange blocks for each section of aluminum I-bar grating, with block designed to fit over lower flange of I-shaped bearing bars.

Furnish threaded bolts with nuts and washers for each clip required.

Furnish self-drilling fasteners with washers for each clip required.

Attach toe plates to grating by welding, unless otherwise indicated.

Furnish toe plates for attachment in field.

Toe plate height shall be 4 inches (10.2 cm), unless a greater height is indicated.

Fabricate cutouts in grating sections for penetrations indicated. Arrange layout of cutouts to permit grating removal without disturbing items penetrating gratings.

Edge band openings in grating that interrupt 4 or more bearing bars with bars of same size and material as bearing bars.

Do not notch bearing bars at supports to maintain elevation.

Fabricate frames for aluminum gratings from extruded-aluminum shapes to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections. Cut, drill, and tap units to receive hardware and similar items.

Equip units with integrally welded anchors for casting into concrete or building into masonry.

Unless otherwise indicated, space anchors 24 inches (61.0 cm) o.c. and provide minimum anchor units in the form of steel straps 1 1/4 inches (3.2 cm) wide by 1/4 inch (6.4 mm) thick by 8 inches (20.3 cm) long.

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

Finish gratings, frames, and supports after assembly.

2.6 EXPANDED METAL GRATINGS. Provide expanded metal gratings in material, style, size, thickness, weight, and type indicated, or if not indicated, as recommended by manufacturer for indicated applications and design loadings.

Material shall be steel or aluminum as indicated.

Steel Finish shall be unfinished and oiled, shop prime painted, or hot-dipped galvanized after fabrication as indicated.

Aluminum Finish shall be mill as fabricated.

Cut, drill and fit grating sections in shop to maximum extent possible.

Fabricate cutouts in grating sections for penetrations of sizes and at locations indicated. Cut openings neatly and accurately to size; edge-band openings with bars having a thickness not less than overall grating thickness at contact points.

Wherever gratings are pierced by pipes, ducts, and structural members, cut openings neatly and accurately to size and weld a steel strap collar not less than 1/8 inch (3.2 mm) thick to the cut ends. Divide panels into sections only to extent required for installation wherever grating platforms and runways are to be placed around previously installed pipe, ducts, and structural members.

Fit exposed connections accurately together to form hairline joints.

2.7 FASTENERS.

2.7.01 General. Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 5, where built into exterior walls.

2.7.02 Fasteners for Aluminum Gratings. Provide fasteners of aluminum, nonmagnetic stainless steel, zinc-plated steel, or other material warranted by the manufacturer to be compatible with aluminum gratings and other components.

PART 3 – EXECUTION

3.1 INSPECTION. Verify field measurements prior to fabrication.

Where gratings are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the work.

Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to project site in time for installation.

Upon receiving, inspect materials thoroughly for damage or inaccuracies. Grating shall not be damaged during handling and installation.

Verify that opening sizes and dimensional tolerances are acceptable.

Verify that supports and anchors are correctly positioned.

3.2 INSTALLATION. Place frames in correct position, plumb and level. Mechanically cut galvanized finish surfaces. Do not flame cut. Anchor by welding, bolting through saddle clips, flange blocks. Set perimeter closure flush with top of grating and surrounding construction.

Secure to prevent movement. Alignment of supports must be checked before placement of grating units. All bearing surfaces must be clean. Place units on supporting members and adjust into final position with proper bearing, alignment at joints and supports then immediately fasten. Use anchoring devices as supplied or approved by the grating manufacturer and in accordance with the manufacturer's instructions. Coat all cut or sanded surfaces with resin furnished by the grating manufacturer in accordance with the manufacturer's instructions.

Grating covers for flumes, manholes, or pits may rest unanchored in recesses constructed for the purpose. To avoid excessive tolerances, an extra-long panel shall be provided for each unanchored grating cover that exceeds 20 feet (6.1 m) in length. The panel shall be field cut to the required dimension after the remainder of the grating panels have been installed. All other grating shall be securely anchored in place. Each grating panel shall be fastened in place with saddle-clips or flange blocks as illustrated in the NAAMM "Metal Bar Grating Manual". Lindapter "Grate-Fast" or Grating Specialty Co., Inc., "G-Clip" stepped locking fasteners. Clips for steel grating shall be stainless steel. Clips or flange blocks for aluminum grating shall be stainless steel. Clips shall be fastened to supporting steel with Nelson stud-type bolts at least 1/4 inch (6.4 mm) in diameter. All fastener parts shall be stainless steel.

3.2.02 Fastening to In-Place Construction. Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

3.2.03 Cutting, Fitting, and Placement. Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation measured from established lines, levels and free from rack.

Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

3.2.04 Field Welding. Use materials and methods that minimize distortion, develop strength and develop corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately after welding operations.

3.2.05 Corrosion Protection. Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.2.06 Installation of Metal Bar Gratings. Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

Secure removable units to supporting members with type and size of clips and fasteners indicated, or if not indicated as recommended by grating manufacturer for type of installation conditions shown.

Secure non-removable units to supporting members by welding where both materials are the same; otherwise, fasten by bolting as indicated above.

Attach toe plates to gratings by welding, at locations indicated.

3.2.07 Installation of Expanded Metal Gratings. Comply with manufacturer's instructions for installation of gratings.

Place units with straight edge of bond up and with the long direction of diamond-shaped openings parallel with direction of span.

Attach removable units to supporting members by bolting at 6 inch (15.2 cm) intervals.

Attach non-removable units to supporting members by welding, unless otherwise indicated. Space welds at 6 inch (15.2 cm) intervals.

Attach aluminum units to steel supporting members by bolting at 6 inches (15.2 cm) intervals.

Butt edges parallel to long way of diamonds and weld at every second bond point. Place individual grating sections so that diamonds of one piece are aligned with those of adjacent sections.

3.2.08 Cleaning. Clean all exposed surfaces as recommended by the manufacturer. Clean welds and damaged coatings and apply two coats of touch-up primer.

End of Section

SECTION 05550

ANCHOR BOLTS AND EXPANSION ANCHORS

PART 1 – GENERAL

1.1 SCOPE. This section covers cast-in-place anchor bolts, epoxy grouted anchor bolts, threaded rod anchors, adhesive anchors, and expansion anchors to be installed in hardened concrete and masonry.

Additional requirements for equipment anchor bolts are covered in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

Adhesive for the adhesive anchors is specified herein. Epoxy grouting of anchor bolts and threaded rod anchors is covered in Master Specification Section 03600, Grout.

1.2 GENERAL. Unless otherwise specified or indicated on the drawings, all anchor bolts shall be cast-in-place bolts, shall have a diameter of at least 3/4 inch (1.9 cm), and shall be straight-headed. Also acceptable is straight type with embedded nut with or without a plate, or L-shaped. Epoxy grouted anchor bolts, threaded rod anchors which are epoxy grouted, and adhesive anchors indicated or accepted instead of cast-in-place anchor bolts for equipment or structural framing shall be at least 3/4 inch (1.9 cm) in diameter. All cast-in-place anchors in grout-filled masonry shall be at least 1/2 inch (1.27 cm) but not more than 3/4 inch (1.9 cm) in diameter. All expansion anchors shall be at least 1/2 inch (1.27 cm) in diameter.

Anchor bolts and threaded rod anchors for buried service and in splash zones shall be hot-dip galvanized. Anchor bolts, threaded rod anchors, adhesive anchors, and expansion anchors for immersed service shall be stainless steel. Expansion anchors and adhesive anchors for buried service and in splash zones shall be stainless steel. All other anchor bolts, threaded rod anchors, adhesive anchors, and expansion anchors shall be carbon steel unless otherwise specified or indicated on the drawings.

1.2.01 Governing Standards. Comply with the requirements and recommendations set forth in the current publications and addenda thereto of the following standards:

> ASTM (American Society of Testing Materials) A36/A36M – Specification for Pipe Carbon Structural Steel.
>
> ASTM A153/A153M – Specification for Pipe Zinc-Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

ASTM A385 – Practice for Providing High-Quality Zinc Coatings (Hot-Dip).

ASTM A615/A615M – Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM E488 – Test Methods for Strength of Anchors in Concrete and Masonry Elements

ASTM E754 – Test Method for Pullout Resistance of Ties and Anchors Embedded in Masonry Mortar Joints

ASTM E1512 - Test Methods for Testing Bond Performance of Adhesive-Bonded Anchors

ASTM F593 – Specification for Pipe Stainless Steel Bolts, Hex Cap Screws, and Studs.

ASTM F594 – Specification for Pipe Stainless Steel Nuts.

ASTM F1554 – Specification for Anchor Bolts, Steel, 36, 55, and 105-KSI Yield Strength

IFI – Industrial Fastener Institute.

1.3 QUALITY ASSURANCE. Bolts, washers etc. used for anchor installation shall be per Industrial Fastener Institute.

1.3.01 Design Standards. Allowable loads for expansion anchors shall be based upon the final embedment depth after torquing. The final embedment may be assumed to be equal to the embedment depth, as specified on the design document, minus one nut height.

Allowable tension loads shall be equal to or greater than the total of all tension loads acting concurrently on an anchor. For example, direct tension plus the resultant tension caused by applied moments on the connection.

Allowable shear loads shall be equal to or greater than the total of all shear loads acting concurrently on an anchor. For example, direct shear plus the shear caused by a torsional moment applied to the connection.

Anchor embedment depth shall be calculated by subtracting from the total bolt length the threaded length of bolt, the thickness of the plate, and the thickness of the grout or concrete topping. Anchor embedment depth should not be less than the minimum embedment depth specified in the drawing.

If the actual anchor spacing is less than the required spacing, reduce the allowable loads as follows: An anchor having spacing less than the required spacing with only one other anchor, reduce the allowable load by the ratio of the actual to required spacing. An anchor having spacing less than the required spacing with two or more anchors, reduce the allowable loads by the square of the ratio of the actual to required spacing. Actual spacing shall not be less than 50 percent of the required spacing.

Required spacing between two different diameter anchors shall be average spacing, $[(10D_1 + 10D_2)/2]$. If the actual anchor spacing is less than the required average spacing, reduce the allowable loads as specified above. Spacing violations between grouted-in bolts or embedded bolts shall be evaluated by using shear cone theory on a case-by-case basis.

The anchor size, anchor length and spacing should be indicated in the appropriate design documents. The manufacturer's standard anchor length shall be specified after allowing for the thickness of the connected parts, any necessary grout, space for nuts and washers, 2 inch (5.08cm) concrete topping if applicable, and the minimum embedment.

1.4 SUBMITTALS.

1.4.01 Drawing and Data. Submit product data on all anchors.

1.4.02 Certificates. Submit ICC-ES Evaluation Reports for all anchors.

PART 2 – PRODUCTS

2.1 MATERIAL.

2.1.01 Anchor, Bolts and Nuts.

Carbon Steel	ASTM A307
Stainless Steel	Bolts, ASTM F593, Alloy Group 1 or 2; nuts, ASTM F594, Alloy Group 1 or 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.

2.1.02 Threaded Rod, Anchors and Nuts.

Carbon Steel	ASTM A307 or ASTM F1554, Grade 36
Stainless Steel	Bolts, ASTM F593, Alloy Group 1 or 2; nuts, ASTM F594, Alloy Group 1 or 2, IFI-104, Grade 304 or 316.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.

2.1.03 Adhesive Anchors (for concrete and grout filled masonry).

System	Hilti “HIT-HY 200System”, ITW Ramset/Redhead “Epcon Ceramic 6 System
Threaded Rod, Anchors and Nuts	As specified for threaded rod anchors.
Adhesive	Two-component liquid, moisture-insensitive epoxy adhesive with viscosity appropriate for the location and application. Components shall be packaged at the factory in a dual-chambered cartridge.

2.1.04 Adhesive Anchors (for hollow masonry).

System	Hilti HI-HY 70, ITW Ramset/Redhead “Epcon Ceramic 6 System
Threaded Rod, Anchors and Nuts	As specified for threaded rod anchors.
Adhesive	Two-component liquid, moisture-insensitive epoxy adhesive with viscosity appropriate for the location and application. Components shall be packaged at the factory in a dual-chambered cartridge.
Screen Tubes	As recommended by the manufacturer.

2.1.05 Flat Washers. Shall be ANSI B18.22.1, of the same material as anchor bolts and nuts.

2.1.06 Expansion Anchors for Concrete. Shall be Hilti “Kwik-Bolt III”, ITW Ramset/Redhead “Thrubolt Wedge Anchor”, Powers “Power-Stud Anchor”, or approved equal.

Anchors shall comply with Fed Spec FF-S-325. Wedge type shall be Group II, Type 4, Class 1 or 2; self-drilling type shall be Group III, Type 1; and nondrilling type shall be Group VIII, Type 1 or 2.

2.1.07 Expansion Anchors for Masonry. Shall be Fed Spec FF-S-325; lag shield (zinc) type, Group II, Type 1; or split shield type, Group II, Type 3, Class 3, and be Hilti, ITQ Ramset-Redhead, Powers, or approved equal.

2.1.08 Reinforcing Bars. Shall be ASTM A615, Grade 60, deformed.

PART 3 – EXECUTION

3.1 GENERAL. Cast-in-place bolts shall have a diameter of at least 1/2 inch (1.27 cm) and shall be "L" shaped unless otherwise indicated or accepted. Expansion anchors for equipment or structural framing shall have a diameter of at least 3/4 inch (1.9 cm). All other expansion anchors shall have a diameter of at least 1/2 inch (1.27 cm).

3.2 ANCHOR BOLTS. Anchor bolts shall be delivered in time to permit setting before the structural concrete is placed. Anchor bolts which are cast-in-place in concrete shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or supporting template. Anchor bolts which are to be epoxy grouted shall be clean and free of coatings that would weaken the bond with epoxy.

Two nuts, a jam nut, and a washer shall be furnished with each anchor bolt indicated on drawings to have locknuts. Two nuts and a washer shall be furnished for all other anchor bolts.

Anti-seize thread lubricant shall be liberally applied to projecting threaded portions of stainless steel anchor bolts immediately before final installation and tightening of the nuts.

Anchor bolts shall be cast in place and, when acceptable to the Engineer or indicated on the drawings, may be epoxy grouted anchor bolts, threaded rod anchors, or adhesive anchors. Anchor bolts, threaded rod anchors, and adhesive anchors which are to be epoxy grouted shall be clean and free of coatings that would weaken the bond of the epoxy. Anchor bolts which are to be epoxy grouted shall not be installed in fresh concrete until it has been allowed to cure for 14 days.

3.3 THREADED ROD ANCHORS. When acceptable to the Engineer, threaded rod anchors may be used in locations where cast-in-place anchor bolts are specified. Adhesive for threaded rod anchors shall be as specified in the Master Specification Section 03600, Grout. The embedment depth for threaded rod anchors shall be at least 15 rod diameters.

3.4 ADHESIVE ANCHORS. When adhesive anchors are indicated on the drawings, only an acceptable adhesive anchor system shall be used. Alternative anchoring systems may be used only when acceptable to the Engineer. An acceptable adhesive anchor system may be used as an alternative in locations where epoxy grouted anchor bolts and threaded rod anchors are specified or indicated. The embedment depth for adhesive anchors shall be at least 15 rod diameters.

Adhesive for adhesive anchors shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

When acceptable to the Engineer, adhesive anchors shall be anchored in holes drilled into hardened concrete or grout filled masonry. Diameter of holes shall be 1/16 inch (1.6 mm) larger than the outside diameter of the rod. Holes shall be prepared for insertion of the anchors by removing all dust and debris using procedures recommended by the adhesive manufacturer.

Adhesive anchors and holes shall be clean, dry and free of grease and other foreign matter at the time of installation. The adhesive shall be placed, the rods shall be set and positioned, and the adhesive shall be finished, all in accordance with the recommendations of the material manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids, and remain filled with adhesive until completion of the curing period. Adhesive shall be cured in accordance with the recommendations of the adhesive manufacturer.

3.5 EXPANSION ANCHORS. When expansion anchors are indicated on the drawings, only an acceptable expansion anchor shall be used. Alternative anchoring systems may be used only when acceptable to the Engineer. Expansion anchors shall be installed in conformity with the manufacturer's recommendations for maximum holding power, but in no case shall the depth of the hole be less than six bolt diameters. The minimum distance between the center of any expansion anchor and an edge or exterior corner of concrete shall be at least six times the diameter of the bolt. Unless otherwise indicated on the drawings, the minimum distance between the centers of expansion anchors shall be 12 times the diameter of the bolt.

Nuts and washers for expansion anchors shall be as specified for anchor bolts. Anti-seize thread lubricant shall be liberally applied to threaded stainless steel components of expansion anchors immediately before installation.

Expansion anchors shall not be installed in fresh concrete until it has been allowed to cure for 28 days.

End of Section

SECTION 05630

ACCESS HATCHES

PART 1 - GENERAL

1.1 SCOPE. This section includes access hatches with integral curbs, frames, and attachments.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. The roof hatches shall have a clear opening as shown on the drawings, and shall consist of an insulated cover and frame. Material shall be G90 galvanized steel and have a factory applied coat of primer or .090 Aluminum H-14 3003, with a mill finish. Corners shall be fully welded and ground smooth. A gasket between cover and frame shall create a weathertight seal.

Floor hatches shall have a clear opening as shown on the drawings, and shall consist of a cover and frame. Material shall be G90 galvanized sheet and shall have a factory applied coat of primer or .090 aluminum H-14 3003, with a mill finish. Corners shall be fully welded and ground smooth. A gasket between cover and frame shall create an air and watertight seal.

1.2.02 Governing Standards. Comply with the requirements and recommendations set forth in the following standards:

AA – The Aluminum Association.

AAMA – American Architectural Manufacturer's Association.

ASTM (American Society for Testing and Materials) A36/A36M – Specification for Pipe Carbon Structural Steel.

ASTM A568/A568M – Specification for General Requirements for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

ASTM A653/A653M – Specification for Pipe Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

AWS (American Welding Society) D1.1 – Structural Welding Code – Steel.

FMRC – Factory Mutual Research Corporation.

UL – Underwriters Laboratory, Inc.

1.3 QUALITY ASSURANCE. Components and installation shall comply with state and local code authorities. Components and installation shall follow current ADA and CABO/ANSI guidelines.

1.3.01 Manufacturer Qualifications. Furnish assemblies from 1 manufacturer with a minimum of 5 years of documented experience in the fabrication of trench cover, access cover and trench liner assemblies.

1.3.02 Installer Qualifications. Firm shall have 5 years of documented experience in the installation of systems required by this project and acceptable to the manufacturer of the system. Furnish references listing projects of similar size and scope.

1.3.03 Sequencing. Submittals shall be completed and approved prior to award of subcontract for system components. Subcontract for the work of this section shall be planned to allow sufficient time for manufacturer's production and delivery scheduling.

1.3.04 Source Quality Control. All products shall be furnished from an ISO 9002 certified manufacturing facility.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings showing complete fabrication details for all access hatches, including required anchorage to surrounding construction, recesses, blocking, and connections between similar and dissimilar trench cover assemblies. Submit manufacturer's specifications and technical data, including Material Safety Data Sheets, installation instructions and, as required, catalog cuts and templates explaining construction and providing for incorporation into the project.

1.4.02 Certifications. Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer. Furnish certification that components were installed in accordance to manufacturer's engineering data to meet the specified design loads. Submit certificates, copies of independent test reports or research reports showing compliance with specified performance requirements.

1.5 DELIVERY, STORAGE AND HANDLING. Provide temporary protective cover on finished surfaces. Deliver access hatches to job site in clean, new, unopened crates of sufficient size and strength to protect materials during transit. Store components in original containers in a clean, dry location. Handle components with equipment of sufficient size to preclude hazard to personnel or components. Examine hatches upon arrival on site. Notify the carrier and manufacturer of any damage. Store hatch until installation under roof, if possible; or, if stored outside, under a tarp or suitable cover.

1.6 WARRANTY. Manufacturer shall warrant materials to be free of defects in material and workmanship for a period of five years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURER'S. Acceptable manufacturers include Bilco Inc.; Halliday, Inc.; Precision Ladders; Wasco Products, Inc., or approved equal.

2.2 MATERIALS.

2.2.01 Curb. Form curbs from 14 gauge (2.0 mm) galvanized steel of lockforming quality with G90 coating or .090 aluminum H-14 3003, mill finish. Sheathed with 1 inch (2.5 cm) of rigid fiber board insulation. Height shall be 12 inches (30.5 cm) unless indicated otherwise on drawings with 4 inches (10.2 cm) integral flange for securing to roof. Hinges connecting curb to door shall be 1/8 inch (3.2 mm), 2 piece formed steel with 3/8 inch (9.5 mm) pivot pin.

2.2.02 Cover. Form cover from 14 gauge (2.0 mm) galvanized steel of lockforming quality with G90 coating or .090 aluminum H-14 3003, mill finish. Liner shall be 22 gauge (.085 mm) galvanized steel with G90 coating or .090 aluminum H-14 3003, mill finish.

Insulation between cover and liner shall be 1 inch (2.5 cm) thick U.L. plain fiberglass 0.75# density. Cover shall be reinforced as required with 11 gage (3.1 mm) steel or aluminum channel. Extruded rubber gasket with a 20 gauge (1.0 mm) formed steel track shall be securely attached to the liner to make the unit weathertight. A one point cab lock is to be provided with a built-in inside handle on units with a length of 4 feet 6 inches (1.4 m) or less. On units of greater length, a 2 point slam lock shall be provided.

Exterior of cover shall be devoid of hardware with the exception of the outside handle. Outside handle shall be vinyl coated, steel T-handle. Automatic hold-open device shall be formed from 3/16 inch (4.8 mm) steel flat bar and 1/2 inch (1.3 cm) diameter steel round stock with a vinyl grip. Padlock provisions shall be provided on both interior and exterior of unit.

2.2.03 Pressure Control. Opening/closing assistance/resistance shall be provided by enclosed spring shocks.

2.2.04 Hardware. Corrosion resistant hardware and fasteners shall be provided.

2.2.05 Fabrication. The hatch shall be completely fabricated ready for installation before shipment to the site.

2.2.06 Finish. Provide red oxide primer or mill aluminum finish as identified.

2.2.07 Roof Curbs. Prefabricated roof curb shall be of box section design constructed using minimum 18 gauge galvanized (1.3 mm) steel with fully mitered and welded corners, 3 inch (7.6 cm) cant. Roof curbs shall be internally reinforced on any side longer than 3 feet (91.4 cm) and shall have factory installed base plate. Roof curbs shall be insulated with 1 1/2 inch (3.8 cm) thick 3 pound (1.4 kg) density fiberglass insulation and factory installed wood nailers fastened from underside with screws. Curb height shall be 8 inches (20.3 cm) above the finished roof or as detailed. Roof curbs shall be level at the top with pitch built in when deck slopes 1/4 inch per foot (2.1 cm per meter) or greater or as detailed.

PART 3 – EXECUTION

3.1 INSPECTION. Examine rough opening in roof for opening size and awareness.

3.2 PREPARATION. Prior to the beginning of work, conduct a pre-installation conference at the job site. Provide seven calendar days advance written notice ensuring the attendance by competent authorized representatives of the fabricator, building owner’s representative, Engineer, and subcontractors whose work interfaces with the work of this Section.

Review the specifications to determine any potential problems, changes, scheduling, unique job site conditions, installation requirements and procedures and any other information pertinent to the installation. Record the results of the conference and furnish copies to all participants.

3.3 INSTALLATION. Furnish and install access hatch, curbs and accessories per manufacturer’s installation instructions at all openings as detailed on the drawings.

End of Section

INDEX

DIVISION 6 – WOOD AND PLASTICS

SECTION 06100

FRAMING AND SHEATHING CARPENTRY

PART 1 - GENERAL

1.1 SCOPE. This section includes structural floor, wall, and roof framing; built-up structural beams and columns; floor, wall, and roof sheathing; sill gaskets and flashings; preservative treatment of wood; fire retardant treatment of wood; miscellaneous framing and sheathing; and telephone and electrical panel back boards.

1.2 GENERAL.

1.2.01 Governing Standards. The work in this section shall comply with the following specifications as appropriate:

AHA (American Hardboard Association) A135.4 - Basic Hardboard.

ALSC (American Lumber Standards Committee) - Softwood Lumber Standards.

ANSI (American National Standards Institute) A208.1 – Mat-Formed Wood Particleboard.

APA/EWA (APA/The Engineered Wood Association) – Certification.

ASTM (American Society of Testing and Materials) A153/A153M – Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

ASTM C220 – Specification for Flat Asbestos–Cement Sheets.

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

AWPA (American Wood Preservers Association) C1 – All Timber Products - Preservative Treatment by Pressure Processes.

AWPA C20 – Structural Lumber-Fire retardant Treatment by Pressure Processes.

AWPB (American Wood Preservers Bureau) Standard – LP-2 – Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservatives for Above-Ground Use.

Fed. Spec. (Federal Specification) – TT-P-38D – Paint, Aluminum, Ready-Mixed.

NELMA (Northeastern Lumber Manufacturers Association).

NFPA (National Forest Products Association).

National Design Specification for Wood Construction.

NIST PS 1 (National Institute of Standards and Technology) – Construction and Industrial Plywood.

NIST PS 20 – American Softwood Lumber Standard.

NLGA (National Lumber Rules Authority).

RIS (Redwood Inspection Service) – Lumber Grading Rules.

SPIB (Southern Pine Inspection Bureau) – Lumber Grading Rules.

WCLIB (West Coast Lumber Inspection Bureau) - Lumber Grading Rules.

WWPA (Western Wood Products Association) – Lumber Grading Rules.

1.3 QUALITY ASSURANCE. All lumber shall be in accordance with a Lumber grading Agency Certified by ALSC. All wood structural panels shall be stamped and certified by EWA (The Engineered Wood Association).

Lumber shall comply with NIST PS 20 and approved grading rules and inspection agencies. Each piece of lumber shall have grade stamp applied by inspection agency and showing compliance with each specified requirement.

Construction panels shall comply with NIST PS 1 where veneer plywood is specified. Comply with APA PRP-108 where APA rated panels are specified, bearing APA trademark showing compliance with each specified requirement.

Particleboard shall comply with ANSI A208.1, factory marked with grade mark.

Each piece of fire-retardant treated lumber or plywood shall have stamp applied by inspection agency, and showing compliance with specified standards.

1.3.01 Tolerances. Framing members shall not exceed 1/4 inch (6.4 mm) from true position, maximum.

Surface flatness of floor shall not exceed 1/4 inch in 10 feet (6.3 mm in 3 m) maximum, and 1/2 inch in 30 feet (1.4 cm in 10 m) maximum.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings for all shop and site fabricated truss frames showing dimensions, wood species and grades, component profiles, drilled holes, fasteners, connectors, erection details and sequence.

Submit technical data on insulated sheathing, preservative treatment of lumber, and application instructions.

1.4.02 Certifications. Submit Manufacturer's Certificate that products conform to specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING. Protect wood products against moisture and dimensional changes. Support stacks at several uniformly spaced points to prevent deformation. Store stacks raised above ground. Cover to protect from rain and snow. Select and arrange cover to allow air circulation under and all around stacks to prevent condensation. Maintain and restore displaced coverings. Remove from the site any wood products that have been subjected to moisture or that do not comply with the specified requirements.

PART 2 - PRODUCTS

2.1 LUMBER MATERIALS. Specify lumber either by specifying by Stress Group or by generic lumber species. Verify that either method used addresses the stress requirements.

Stress Group Species (Commercial Design)

A - Douglas Fir, Larch
B - Hem-Fir
C - Eastern Hemlock, Tamarack, Jack Pine, Pacific Coast Yellow Cedar
D - Pacific Coast Sitka Spruce, Ponderosa Pine, Spruce-Pine-Fir
E - Eastern White Pine, Red Pine, Western Cedars, Western White Pine

2.1.01 Lumber Grading Rules. Lumber shall conform to and bear the grade and trademark of Manufacturer’s Association under which produced. Each piece of lumber and plywood shall be marked at the factory with grade, type, mill, and grading agency except on lumber intended to receive transparent finish.

Joist, Rafter, and Stud Framing for above grade applications shall be Spruce-Pine-Fir (S.P.F.) species, 19 percent maximum moisture content. Below Grade Joist and Stud Framing shall be Stress Group B and preservative treated. Below Grade Wall Sheathing shall be plywood, 3/4 inch (1.9 mm) thick, 24 x 48 inch (61.0 x 122.0 cm) sized sheets, tongue and groove edges, and preservative treated. Sloped Roof Sheathing shall be plywood, 3/8 inch (9.5 mm) thick, 24 x 48 inch (61.0 x 122.0 cm) sized sheets, square edges; appearance grade facing inward.

2.1.02 Materials. Studs, posts and miscellaneous light framing shall be stud grade or better Douglas Fir, Hem-Fir, S.P.F. or Southern Pine. Wall framing shall typically be of 2 x 4 inch (5.1 x 10.2 cm) or 2 x 6 inch (5.1 x 15.2 cm) (nominal size) wood studs and plates, stud spacing and sizes shall be as indicated on the drawings.

All sill plates in contact with concrete shall be preservative treated. Sill plate at exterior walls shall rest on 1/2 inch (1.3 cm) thick glass fiber or polyfoam sealer blanket of full width of plate. Sill plates shall be anchored to foundation walls with 1/2 inch (1.3 cm) diameter anchor bolts spaced at 4 feet (1.2 m) center to center maximum.

Subflooring shall be 3/4 inch (1.9 cm) thick 48/24 tongue-and-groove underlayment grade Southern Yellowpine plywood, interior grade with exterior glue or 3/4 inch (1.9 cm) tongue-and-groove oriented strand board (OSB). Subflooring shall have its long sheet dimensions perpendicular to the span direction of floor trusses, with ends of sheets staggered except at perimeter of the building. Subflooring shall be both glued and nailed to floor trusses.

Stairs shall have fir treads, risers and stringers. Treads and stringers shall be nominal 2 inch (5.1 cm) thickness, risers shall be nominal 1 inch (2.5 cm) thickness.

Provide metal “T” straps at all exterior building corners for wind bracing and stability. Cover all exposed wood with 15# felt prior to the application of finish siding or brick veneer.

Sheathing at exterior walls and at gable end shall be 1/2 inch (1.3 cm) thick C-D fir plywood with exterior glue or 1/2 inch (1.3 cm) thick oriented strand board (OSB). All exterior walls shall be wrapped with one layer of DuPont TYVEK Housewrap before installation of exterior finish materials.

Roof sheathing shall be 1/2 inch (1.3 cm) thick CDX plywood with exterior glue. Roof sheathing shall have unsupported edges blocked with “H” clips (one per unsupported space less than 48 inches (1.2 m) and two for broader spaces).

Headers, rafters, and other members shall be Southern Pine or Douglas Fir, No. 2 or better with the following properties according to the specific span dimensions contained in the National Forest Products Association span tables:

> Minimum allowable bending stress of F_b = 1000 psi (6,894.8 kPa), (1150 psi (7,929 kPa) repetitive).
>
> Shear stress F_v = 90 psi (620.5 kPa).
>
> Modulus of elasticity E = 1,600,000 psi (11,031.7 kPa).

Nailers and interior blocking shall be utility grade spruce, pine, fir or equivalent grade of Southern Pine, surfaced four sides. Use pressure treated material to resist rot and fungus in areas in contact with concrete.

Plywood for interior rough carpentry shall be C-D Interior APA in thickness shown on drawings, species to be selected accordingly. Plywood for built in shelving units shall be premium grade, 3/4 inch (1.9 cm) solid red oak material.

Plywood soffits shall be American Plywood Association rough sawn fir plywood. Plywood shall be A/C grade or better, tightknot, 3/8 inch (9.5 mm) thick. Provide 2 inch (5.1 cm) wide continuous aluminum soffit vent with integral screen in all soffit vent with integral screen in all soffit areas, color as selected by the Engineer.

Exterior wood trim shall be rough sawn cedar, 1 inch (2.5 cm) nominal thickness, No. 2 tight knot or better.

Plastic flashing around door and window openings shall be 6 mil (0.2 mm) thickness of sheet polyethylene, wrapping the rough framing and sheathing at head, jambs and sill, bonds and corners.

Provide wooden roof and floor trusses where shown on the drawings, with spacing indicated on the drawings. Trusses shall be manufactured by a company experienced in the fabrication of wood trusses. Shop drawings of trusses shall be submitted by the manufacturer and shall bear the seal of an Engineer registered in the State of Michigan. Truss drawings shall include each type of truss and it’s suitability for the span and spacing. Roof trusses to have heel height as indicated on the drawings. Provide truss location drawings when submitting roof truss drawings for review.

2.1.03 Preservative Treatment of Lumber.

Lumber that will be installed below grade, exposed to the environment, or as requested by the Engineer shall be pressure treated by a process of Koppers Company (Wolman Preservative Department) or equal impregnating it with preservative salts in a closed cylinder by vacuum pressure process in accordance with treatment specifications of the processor.

Lumber that will be exposed to high temperatures such as on roofs or as requested by the Engineer will be non-combustible.

Where required by code or as requested by the Engineer, lumber shall be both pressure treated and non-combustible “Exterior Fire X” fire-retardant pressure impregnated lumber produced by Hoover Treated Wood Products of Pine Bluff, Arkansas or Milford, Virginia or equal. Lumber shall be treated with a fire hazard classification in Underwriter Laboratories tests or 30 minutes duration, showing flame-spread rating not exceeding 25 and no evidence of significant progressive combustion. After treatment, all lumber up to 2 inches (5.1 cm) in thickness shall be dried to maximum moisture content of 18 percent.

Each piece of lumber shall bear a label indicating conformance to standards of the processor.

2.2 ACCESSORIES. Fasteners shall be hot dipped galvanized steel for high humidity and treated wood locations, unfinished steel elsewhere.

Anchors shall be toggle bolt type for anchorage to hollow masonry. Use expansion shield and lag bolt types for anchorage to solid masonry or concrete. Use bolt or ballistic fastener for anchorage to steel.

Sill gasket on top of foundation wall shall be 1/4 inch (6.4 mm) thick, plate width, closed cell polyethylene foam from continuous rolls.

Sill flashing (under sill gasket) 6 mil (0.2 mm) thick, polyethylene sheet.

Subfloor glue shall be EWA AFG-01, waterproof, base, air cure type, cartridge dispensed.

Building paper shall be No.15 asphalt felt plain untreated cellulose building paper and spun bonded polyethylene.

Termite shield shall be galvanized sheet steel, plastic.

PART 3 - EXECUTION

3.1 FRAMING. Set structural members level and plumb, in correct position. Place horizontal members, crown side up. Coordinate installation of wood decking, wood chord metal joists, glue laminated structural units, prefabricated wood trusses, and wood joists. Coordinate curb installation with installation of decking and support of deck openings, roofing vapor retardant, and parapet construction.

Make provisions for sufficient temporary bracing of erection loads to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.

Double up members at openings over 60 inches (1.5 m) wide. Frame double joist headers rigidly into joists at floor opening; ceiling openings, and under wall stud partitions that are parallel to floor joists. Bridge or brace between joist framing in excess of 8 feet (2.4 m) span at mid-span to prevent buckling. Fit solid blocking bridging at ends of members. Space short studs over and under opening to stud spacing.

Place full width continuous sill flashings under framed walls on cementitious foundations. Overlap flashing joints by 4 inches (10.2 cm). Place sill gasket directly on cementitious foundation. Puncture gasket clean and fit tight to protruding foundation anchor bolts.

3.2 <u>SHEATHING</u>. Attach roof sheathing with longer edge (strength axis) perpendicular to framing members, with ends staggered, and sheet ends over bearing structure. Use sheathing clips at joints between sheathing sheets along edges perpendicular to roof framing members.

Secure wall sheathing with long dimension to wall studs, with ends over firm bearing, perpendicular for exterior and parallel for interior walls. Place building paper horizontally over wall sheathing; weather lap edges and ends.

Secure subfloor sheathing with longer edge perpendicular to floor framing, with end joints staggered, and sheet ends over bearing structure. Attach with subfloor glue and nails. Place building paper between floor underlayment and subflooring. Install flooring underlayment after dust and dirt generating activities have ceased and prior to application of finished flooring. Apply underlayment perpendicular to subflooring and stagger joints of underlayment.

Install telephone and electrical panel back boards with wood structural panel sheathing material where required. Size the back board12 inches (30.5 cm) beyond size of electrical panel.

3.3 <u>SITE APPLIED WOOD TREATMENT</u>. Brush-apply two coats of preservative treatment on wood in contact with cementitious materials roofing and related metal flashings. Treat site-sawn cuts. Allow preservative to dry prior to erecting members.

End of Section

SECTION 06114

WOOD BLOCKING AND CURBING

PART 1 - GENERAL

1.1 SCOPE. This section specifies roof curbs, cants, and perimeter nailers; blocking in wall and roof openings; wood furring and grounds; and concealed wood blocking for support of bathroom accessories, wall cabinets, and wood trim.

1.2 GENERAL. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

ALSC (American Lumber Standards Committee) – Softwood Lumber Standards.

APA/EWA (APA/Engineered Wood Association) – Certification.

ASTM E84 (American Society for Testing and Materials) - Test Method for Surface Burning Characteristics of Building Materials.

AWPA C1 (American Wood Preservers Association) – All Timber Products - Preservative Treatment by Pressure Process.

AWPA C20 – Structural Lumber Fire Retardant Treatment by Pressure Process.

AWPA C27 – Plywood – Fire-Retardant Treatment by Pressure Processes.

NFPA (National Forest Products Association) – Lumber Grading Rules.

NLGA (National Lumber Rules Authority).

RIS (Redwood Inspection Service) – Lumber Grading Rules.

SPIB (Southern Pine Inspection Bureau) – Lumber Grading Rules.

WCLIB (West Coast Lumber Inspection Bureau) – Lumber Grading Rules.

WWPA (Western Wood Products Association) – Lumber Grading Rules.

1.3 QUALITY ASSURANCE. Perform Work in accordance with a Lumber Grading Agency that is certified by ALSC.

The Plywood Grading Agency shall be certified by APA/EWA.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit technical data on wood preservative and fire retardant treatment materials and provide application instructions where required.

PART 2 - PRODUCTS

2.1 MATERIALS. Lumber grading rules shall follow WWPA Standards.

Stress Group Species (Commercial Design)

A - Douglas Fir, Larch

B - Hem-Fir

C - Eastern Hemlock, Tamarack, Jack Pine, Pacific Coast Yellow Cedar

D - Pacific Coast Sitka Spruce, Ponderosa Pine, Spruce-Pine-Fir

E - Eastern White Pine, Red Pine, Western Cedars, Western White Pine

Miscellaneous framing, to include blocking and curbing shall be stress Group D or better, No. 2 grade, and 19 percent maximum moisture content after treatment.

Lumber for curbing shall be non-combustible.

2.1.01 Accessories. Use hot dipped galvanized steel fasteners for high humidity and treated wood locations. Use unfinished steel elsewhere.

Use toggle bolt type anchors for anchorage to hollow masonry. Use expansion shield and lag bolt type for anchorage to solid masonry or concrete. Use bolt or ballistic fastener for anchorage to steel.

2.2 WOOD TREATMENT. Each piece of lumber shall be stamped to reflect treatment and conformance to standards for treatment.

2.2.01 Preservative Treatment of Lumber. Non- finish lumber that will be installed below grade, exposed to the environment, or as requested by the Engineer shall be pressure treated by a process of Koppers Company (Wolman Preservative Department) or equal impregnating it with preservative salts in a closed cylinder by vacuum pressure process in accordance with treatment specifications of the processor.

2.2.02 Fire Retardant Treated Wood. Lumber that will be exposed to high temperatures such as on roofs or as requested by the Engineer will be fire retardant treated wood (FRTW) impregnated with fire-retardant chemicals and complying with AWPA C20 for lumber and with AWPA C27 for plywood. Lumber shall have surface burning characteristics not exceeding a flame spread of 25 when tested in accordance with ASTM E84 for not less than 10 minutes.

2.2.03 Exterior Fire Retardant Treated Wood. Where required by code or as requested by the Engineer, lumber shall be both pressure treated and non-combustible fire-retardant pressure impregnated “Exterior Fire X” lumber produced by Hoover Treated Wood Products, “NCX” by Koppers Company, or equal. Lumber shall be treated with a fire hazard classification in Underwriters Laboratories tests of 30 minutes duration, showing flame-spread rating not exceeding 25 and no evidence of significant progressive combustion. After treatment, all lumber up to 2 inches (5.08 cm) in thickness shall be dried to maximum moisture content of 18%.

PART 3 - EXECUTION

3.1 CURB ROOF OPENINGS. Construct curb members of solid full length wood sections without splices. Form corners by alternating lapping side members. Coordinate curb installation with installation of decking and support of deck openings, roofing vapor retardant, and parapet construction.

3.2 BLOCKING. Blocking shall be provided behind wall cabinets, hand rails, bathroom accessories, wood trim, and telephone and electrical panel backboards.

3.3 SITE APPLIED WOOD TREATMENT. Brush apply one coat of preservative treatment on wood in contact with cementitious materials roofing and related metal flashings. Treat site-sawn cuts. Allow preservative to dry prior to erecting members.

End of Section

SECTION 06170

TRUSSES, JOISTS, AND ROOFING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section includes trusses fabricated from dimension lumber, metal-web and plywood I Joists, plate connectors, engineering of trusses, erection of trusses, erection accessories, bracing, bridging, and attachment to structure.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

ALSC (American Lumber Standards Committee) – Softwood Lumber Standards.

ANSI (American National Standards Institute, Inc.) A208.1 – Mat-Formed Wood Particleboard.

APA (American Society for Testing and Materials) – Plywood Grading Rules.

APA/EWA TB-200 (APA/Engineered Wood Association) – Technical Bulletin (Fire Retardant).

ASTM (American Society for Testing and Materials) A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

AWPA (American Wood Preservers Association) C1 – All Timber Products Preservative Treatment by Pressure Process.

NFPA (National Forest Products Association) – Lumber Grading Rules.

NIST (National Institute of Standards and Technology) PS20C – American Softwood Lumber Standard.

RIS (Redwood Inspection Service) – Lumber Grading Rules.

SPIB (Southern Pine Inspection Bureau) – Lumber Grading Rules.

TPI (Truss Plate Institute) 80 - "Design Specification for Metal Plate Connected Parallel Chord Wood Trusses."

TPI-85 - "Design Specification for Metal Plate Connected Wood Trusses."

TPI-89 - "Quality Standard for Metal Plate Connected Wood Trusses."

TPI DSB-89 - Recommendations Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses.

TPI HIB-91 – Commentary and Recommendations for Handling, Installing and Bracing Metal Plate Connected Wood Trusses.

ANSI/TPI 1 - National Design Standard for Metal Plate Connected Parallel Chord Wood Trusses.

WCLIB (West Coast Lumber Inspection Bureau) – Lumber Grading Rules.

WWPA (Western Wood Products Association) – Lumber Grading Rules.

1.3 QUALITY ASSURANCE. Provide trusses fabricated as specified herein and complying with the following:

TPI-85 - "Design Specification for Metal Plate Connected Wood Trusses."

TPI-80 - "Design Specification for Metal Plate Connected Parallel Chord Wood Trusses."

TPI-89 - "Quality Standard for Metal Plate Connected Wood Trusses."

Lumber quality shall comply with NIST PS 20 and applicable grading rules. Provide factory marking on each lumber member showing type, grade, mill, and grading agency.

1.3.01 Manufacturer's Qualifications. Manufacturer shall have a minimum 5 years of documented experience in successful fabrication of wood trusses similar to type required for this work and shall be licensed by TPI under "Quality Assurance Inspection Program" to apply TPI marks to trusses. Manufacturer shall maintain an in-plant quality control program that assures compliance with TPI QST "Quality Standard for Metal Plate Connected Wood Trusses" and includes independent testing agency inspections.

1.3.02 Contractor's Qualifications. Contractor shall have a minimum of 5 years documented experience in the successful installation of this type of work. Contractor shall be certified by truss manufacturer.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit detailed shop drawings for fabrication and erection of trusses including plans, elevations, and large scale details of special connections, joining, and accessories. Include mark, number, location, and spacing of trusses and bridging. Show dimensions, applied loadings, reactions, and permanent bracing. Provide templates or location drawings of anchors or bearing accessories to be installed as work of other sections. Shop drawings shall be sealed by a Professional Engineer registered in Michigan.

1.5 DELIVERY, STORAGE, AND HANDLING. Handle units to avoid damage. Comply with manufacturer's printed instructions. Schedule delivery of units to arrive in time for prompt erection without prolonged storage on site. Protect structural components from warping or other distortion by stacking vertically and bracing to resist movement.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Design trusses to support dead loads and to withstand live loads as indicated on the drawings.

2.2 ACCEPTABLE MANUFACTURERS.

2.2.01 Wood Trusses. Acceptable manufacturers include Alpine Engineered Products, Inc.; Standard Structures, Inc.; Warren Truss Co.; or approved equal.

2.2.02 Plywood I Joists. Acceptable manufacturers include Georgia Pacific Corp.; Louisiana - Pacific Corp.; Truss Joist Mac Millan; Weyethaeuser Engineered Structural Products; or approved equal.

2.2.03 Metal-Web Wood Joists. Acceptable manufacturers include Apline Engineered Products, Inc.; Rigidply Rafters Inc.; Weyethaeuser Engineered Structural Products; or approved equal.

2.3 LUMBER. Lumber surfacing shall be dressed, S4S. Moisture content shall be 19 percent maximum at time of dressing and shipment.

Provide machine stress rated (MSR) lumber as determined by truss connector plate manufacturer's engineering of trusses having the following minimum design values or visually graded lumber having the following minimum design values listed in the NFPA "Design Values for Wood Construction" (NDS Supplement).

E (modulus of elasticity): 1,400,000 psi (9,652.7 MPa), minimum.

F_b - single (extreme fiber stress in bending): 1500 psi (10342.7 kPa), minimum.

F_c (compression parallel to grain): 1200 psi (8273.8 kPa).

F_t (tension parallel to grain): 900 psi (6205.3 kPa).

Fabricate connector plates from sheet metal meeting the following requirements:

Structural properties shall meet ASTM A 446, any grade.

Finish shall be hot-dip galvanized; ASTM A 525, G60, minimum.

Thickness shall be as required by truss design but not less than 20 gage (1.0 mm).

2.4 CONNECTOR, PLATES, FASTENERS AND ANCHORAGES. Provide size, type, materials, and finish for fasteners as indicated that comply with applicable federal standards for each type of fastener. Finish for nails shall be plain or coated. Threaded steel fasteners shall be zinc or cadmium coated.

2.5 MANUFACTURE AND FABRICATION. Fabricate trusses to achieve structural requirements specified.

Brace wood trusses for support in accordance with TPI HIB-91. Brace all trusses for support during transit.

Provide bottom and top chord extensions as indicated. Fabricate to achieve minimum end bearing area surfaces as defined by truss manufacturer for steel, masonry, or wood as detailed. Frame special sized opening in web framing as detailed.

Shop fabricate wood trusses to comply with TPI QST "Quality Standard for Metal Plate Connected Wood Trusses" and to fulfilL design requirements. Press connectors into both sides of joint simultaneously.

2.5.01 Metal-Web Wood Joists.

Wood Chord Members shall be single top and bottom chord. Finger scarfing shall not be permitted. Web members shall be cold rolled steel tubing, galvanized, minimum yield strength of accurately die stamped, electrically welded. Connecting pins shall be electro-galvanized structural carbon steel. Joist bridging shall be of type, size and spacing recommended by joist manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that supports and openings are ready to receive trusses. Verify that bearing areas are in correct location and of proper dimensions.

3.2 PREPARATION. Coordinate placement of support and anchorage accessories. Inspect trusses for damage and loosening of connector plates before installation. If acceptable to the architect, make repairs in accordance with truss connector plate manufacturers; otherwise, replace trusses which cannot be properly repaired.

3.3 INSTALLATION. Install trusses in accordance with manufacturer's instructions for erection. Truss spacing shall be 24 inches (61.0 cm) on center, typical or as detailed. Install trusses true to line and level, with webs plumb, and with ends accurately located. Provide temporary bracing to hold trusses upright and in place until permanently secured. Install permanent bridging, bracing, and anchors to maintain trusses straight and in correct position before installing supported construction or superimposing loads. Field cutting of truss members is not allowed. Coordinate installation of framing to be attached to or supported by trusses. Verify that concentrated loads will occur only at locations incorporated into the design of the trusses. Lift trusses at designated lifting points only.

End of Section

SECTION 06200

FINISH CARPENTRY

PART 1 - GENERAL

1.1 SCOPE. This section covers finish carpentry and includes carpentry work which is exposed to view, is non-structural, and which is not specified as part of other sections.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified the work of this section shall conform to the applicable portions of the following standard specifications.

AHA (American Hardboard Association) A135.4 – Basic Hardboard.

ANSI (American National Standards Institute, Inc.) A208.1 – Wood Particleboard.

ASTM (American Society for Testing and Materials) A153/A153M – Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM C1036 – Specification for Flat Glass.

ASTM C1048 – Specification for Standard Specification for Heat-Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.

ASTM D2898 – Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

AWI (Architectural Woodwork Institute) – Architectural Woodwork Quality Standards Illustrated.

AWPA C1 (American Wood Preservers Association) – All Timber Products Preservative Treatment by Pressure Processes.

AWPA C20 – Structural Lumber Fire Retardant Treatment by Pressure Processes.

AWPA C27 – Plywood – Fire- Retardant treatment by Processes.

BHMA A156.9 (Builders Hardware Manufacturers Association) – American National Standard for Cabinet Hardware.

Fed. Spec. (Federal Specification) MMM-A-130 – Adhesive, Contact.

HPVA HP-1 (Hardwood Plywood and Veneer Association) – Voluntary Standard for Hardwood and Decorative Plywood.

NEMA LD 3 (National Electric Manufacturer's Association) – High Pressure Decorative Laminates.

NHLA (National Hardwood Lumber Association).

NIST PS 1 (National Institute of Standards and Technology) – Construction and Industrial Plywood.

NIST PS 20.

NIST PS 51.

NIST PS 56.

NWWDA I.S.4 (National Wood Window and Door Association) – Industry Standard for Water-Repellent Preservative Non-Pressure Treatment for Millwork.

WIC (Woodwork Institute of California) – Manual of Millwork Standards of the Woodwork Standards of the Woodwork Industry.

1.3 QUALITY ASSURANCE. Factory-mark each piece of lumber and plywood with type, grade, mill and grading agency identification. Omit marking from surfaces to receive transparent finish, and submit mill certificate that material has been inspected and graded in accordance with requirements if it cannot be marked on a concealed surface.

Mark each unit of fire-retardant treated lumber and plywood with classification marking of Underwriters Laboratory, Inc., or other testing and inspecting agency acceptable to authorities having jurisdiction. Place marking on surfaces which will not be exposed after installation.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit manufacturer's specifications and installation instructions for each item of factory-fabricated siding and paneling. Submit wood treatment manufacturer's instructions for handling, storage, installation and finishing treated materials.

1.4.02 Certifications. Include certification by fire-retardant treating plant indicating type of chemicals used and fire performance characteristics achieved.

1.4.03 Samples. Submit samples for each species and cut or pattern of finish carpentry upon request.

1.5 DELIVERY, STORAGE, AND HANDLING. Protect finish carpentry materials during transit, delivery, storage and handling to prevent damage, soiling and deterioration.

Do not deliver finish carpentry materials, until painting, wet work, grinding and similar operations which could damage, soil or deteriorate woodwork have been completed in installation areas. If finish carpentry materials must be stored in other than installation areas, store only in areas meeting requirements specified for installation areas.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Installer shall advise Contractor of temperature and humidity requirements for finish carpentry installation areas. Do not install finish carpentry until required temperature and relative humidity conditions have been stabilized and will be maintained in installation areas until occupancy.

Maintain temperature and humidity in installation area as required to maintain moisture content of installed finish carpentry within a 1.0 percent tolerance of optimum moisture content, from date of installation through remainder of construction period. The fabricator of woodwork shall determine optimum moisture content and required temperature and humidity conditions.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Softwood lumber shall comply with NIST PS 20 and with applicable grading rules of the respective grading and inspecting agency for the species and product indicated.

Plywood shall comply with NIST PS 1.

Hardwood lumber shall comply with National Hardwood Lumber Association (NHLA) rules.

Hardwood plywood shall comply with NIST PS 51.

Woodworking shall comply with Architectural Woodwork Institute (AWI) "Quality Standards".

Glued-up lumber shall comply with NIST PS 56.

2.3 MATERIALS. Nominal sizes are indicated, except as shown by detailed dimensions. Provide dressed or worked and dressed lumber, as applicable, manufactured to the actual sizes as required by NIST PS 20 or to actual sizes and patterns as shown, unless otherwise indicated.

Provide seasoned softwood (KD) lumber having a moisture content from time of manufacture until time of installation not greater than values required by the applicable grading rules of the respective grading and inspecting agency for the species and product indicated.

Provide kiln-dried hardwood (KD) lumber having a moisture content from time of manufacture until time of installation within the ranges required in the reference woodworking standard.

Lumber to receive a transparent finish (stained or clear) shall be made of solid lumber stock.

Provide concealed nails, screws and other anchoring devices complying with applicable Federal Specifications of the type, size, material, and finish required for application indicated to provide secure attachment. Where finish carpentry is exposed on exterior or in areas of high relative humidity, provide fasteners and anchorages with a hot-dipped zinc coating (ASTM A153).

2.4 WOOD TREATMENT.

2.4.01 Preservative Treatment (Trt-Wd). Following basic fabrication provide 3 minute dip treatment of finish carpentry items indicated to receive preservative treatment in 5 percent solution of pentachlorophenol, with vehicle which will not interfere with finish application and will produce minimum effect upon appearance. Apply brush coat on surfaces cut after treatment.

2.4.02 Fire Retardant Treated Wood (FRTW). Where wood is indicated as "FRTW" impregnate with fire-retardant chemicals and with following requirements.

For lumber, comply with AWPA C 20 except as otherwise indicated.

For plywood, comply with AWPA C 27 except as otherwise indicated.

Provide materials with surface burning characteristics not exceeding flame spread of 25 when tested in accordance with ASTM E84 for not less than standard time period (10 minutes).

For FRTW wood exposed to exterior, use treatment chemicals and process which show no increase in surface burning characteristics when tested in accordance with ASTM D2898, Method A (Standard Rain Test). Subject to compliance with requirements, provide "NCX" by Koppers Co., Inc. or "Exterior Firex" by Hoover Universal, Inc.

For FRTW wood used in interior applications not exposed to relative humidities in excess of 92 percent, use treatment chemicals with reduced hygroscopicity which are non-corrosive to metal fasteners, are non-blooming and permit use of transparent oil based finishes. Subject to compliance with requirements, provide "Dricon"; Koppers Company, Inc., "Flameproof LHC"; Osmose Wood Preserving Co. of America, Inc., "Protex"; Hoover Universal Wood Preserving Division, or approved equal.

Kiln-dry wood after treatment shall have a maximum moisture content of 15 percent for plywood, 19 percent for lumber.

Inspect each piece of lumber and plywood or each unit of finish carpentry after drying; do not use twisted, warped, bowed or otherwise damaged or defective wood.

PART 3 - EXECUTION

3.1 PREPARATION. Condition wood materials to average prevailing humidity conditions in installation areas prior to installing.

Notify painter of material delivery date allowing them sufficient time to backprime lumber for painted finish exposed on the exterior or, where indicated, to moisture and high relative humidities on the interior. Painting shall comply with requirements of Master Specification Section 09900, Painting.

Meet at project site prior to delivery of finish carpentry materials to ensure environmental controls required for proper installation and ambient conditioning in areas to receive work. Include in meeting the Contractor’s, Engineer and Owner Representatives involved with work. Work shall be coordinated with installers of finish carpentry, painting, mechanical work, electrical work and persons responsible for continued operation (whether temporary or permanent) of HVAC system as required to maintain temperature and humidity conditions. Proceed with finish carpentry on interior only when everyone concerned agrees that required ambient conditions can be properly maintained.

3.2 INSTALLATION. Discard units of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned, or too small to fabricate work with minimum of joints or optimum jointing arrangements, or which are of defective manufacture with respect to surfaces, sizes or patterns.

Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch (3.2 mm) in 8 feet (2.4 m) for plumb and level countertops; and with 1/16 inch (1.6 mm) maximum offset in flush adjoining 1/8 inch (3.2 mm) maximum offsets in revealed adjoining surfaces.

Scribe and cut work to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts. For standing and running trim, install with minimum number of joints possible, using full-length pieces (from maximum lengths of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, to produce tight fitting joints with full surface contact throughout length of joint. Use scarf joints for end-to-end joints.

Handle, store and install FRTW in accordance with manufacturer's directions and as required to meet required classification or rating. Provide special fasteners, moldings, adhesives and other accessories as tested and listed for type of fire-retardant materials indicated.

Anchor finish carpentry work to anchorage devices or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fasteners heads are required, use fine finishing nails countersunk for exposed nailings. Painter to fill flush with finished surface, and matching final finish where transparent is indicated.

3.2.01 Adjustment. Repair damaged and defective finish carpentry work wherever possible to eliminate defects functionally and visually. Where it is not possible to repair properly, replace woodwork. Adjust joinery for uniform appearance.

3.2.02 Cleaning. Clean finish carpentry work on exposed and semi-exposed surfaces. Touch-up shop-applied finishes to restore damaged or soiled areas.

3.2.03 Protection. Contractor shall maintain finish carpentry work at proper temperature and humidity conditions necessary to ensure that work will be without damage or deterioration at time of acceptance.

End of Section

SECTION 06410

CUSTOM CABINETS

PART 1 - GENERAL

1.1 SCOPE. This section covers architectural woodwork for cabinetry and counters, shelving and architectural wood paneling.

1.2 GENERAL.

1.2.01 Coordination. Take field measurements to verify or supplement dimensions indicated. Coordinate size of related work, such as sinks, plumbing and electrical fixtures, architectural hardware, appliances and equipment. Be responsible for accurate fit of the Work.

1.2.02 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

ANSI (American National Standards Institute, Inc.) A208.1 – Particleboard.

ASTM (American Society for Testing and Materials) E84 - Test Method for Surface Burning Characteristics of Building Materials.

AWI (Architectural Woodwork Institute) Architectural Woodwork Quality Standards Illustrated.

BHMA (Builders Hardware Manufacturers Association) – Cabinet Hardware.

Fed. Spec. (Federal Specification) - TT-P-38D – Paint, Aluminum, Ready-Mixed.

FS MM-A-130 – Adhesive, Contact.

NEMA LD 3 (National Electrical Manufacturers Association) - High-Pressure Decorative Laminates.

NIST PS1 (National Institute of Standards and Technology) – Construction and Industrial Plywood.

TT-V-121H – Varnish, Spar, Water-Resisting.

UL (Underwriters Laboratories Inc.) Building Materials Directory 10B - Fire Tests of Door Assemblies.

1.3 QUALITY ASSURANCE. Perform Work in accordance with AWI (Architectural Woodwork Institute) Architectural Woodwork Quality Standards Illustrated, Premium Grade.

1.3.01 Contractors Qualifications. Contractor shall have specialized in installing Work of this section with a minimum of five years documented experience.

1.3.02 Manufacturers Qualifications. Manufacturer shall be a company specializing in performing Work of this section with a minimum of five years documented experience. Manufacturer shall be authorized to use AWI Grade Stamps, licensed by AWI Quality Certification Program and authorized to provide WIC Certified Compliance Certificate.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit Shop Drawings indicating dimensions, locations, architectural wood panels, method of fastening to backing and layout, wood cabinet erection details, field verified conditions in sufficient detail and scale, and other pertinent details. Furnish maintenance instructions for plastic facing and hardware.

1.4.02 Certifications. Submit copy of fabricator's authorization to use AWI Grade Stamps, AWI Quality Certification Program license and Project specific letters to the Owner and architect. Include WIC certified compliance certificate.

Submit in triplicate a notarized certificate, addressed to the State Fire Marshal or other authority having jurisdiction over the Project, stating that only materials specified to meet the minimum acceptable fire hazard classification have been used in the construction of specified items and listing the items so constructed, with exceptions.

If requested by the Engineer, submit evidence of the manufacturer's experience, including a list of projects for which work similar in scope and quality to this Work was provided.

Submit statement of compliance for plywood for wood paneling and particleboard.

1.4.03 Samples. Submit samples in accordance with AWI "Quality Standards", Section 1500 of hardwood and wood veneer to receive the transparent finish specified in Master Specification Section 09900, Painting. Also include plastic laminate, prefinished wall paneling, laminated wood handrail (showing range of color and grain) and method of making joints, and sealant color.

1.4.04 Mock-Up. Provide mock-up of full size base cabinet and upper cabinet including plumbing and electrical fixtures, hardware and accessories. Mock-up may remain as part of the Work.

1.5 DELIVERY, STORAGE AND HANDLING. Protect the Work by means of suitable cartons or paper bags during transportation to the project site. Damaged items, as determined by the Engineer, shall be replaced.

1.5.01 Storage and Protection. Do not store architectural woodwork items in the building or other storage area unless it is sufficiently dry so that the wood materials will not be damaged by excessive changes in moisture content.

Store architectural wood paneling flat with provision for good circulation of air.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Plywood for Transparent Finish. Hardwood plywood shall comply with AWI Quality Standards, Section 200, requirements for Grade A, and the following:
Face veneer – Natural Teak, as manufactured by Brookside Veneers, or Brookline Mahogany #813/V, as manufactured by Brookside Veneers.

Panels shall be 5-ply lumber core or particleboard core construction with solid hardwood lumber edge banding for exposed ends, core and cross banding having no open defects, and of thickness required to produce balanced construction in overall thickness indicated.

Panels shall be good-one-side with back veneer of species and thickness to balance face veneer.

2.1.02 Plywood for Paint Finish. Softwood plywood complying with PS 1, interior type, A-B grade or faced with medium density overlay.

2.1.03 Lumber. Lumber for exposed portions of wood cabinets to receive transparent finish and wood trim shall be hardwood of same species as plywood face veneer and of AWI Grade I.

Common lumber shall be as specified in Master Specification Section 06100, Framing and Sheathing Carpentry.

2.1.04 Plastic Laminate. Plastic laminate face sheet shall be 0.050 inch (1.3 mm) thick with low-gloss finish; Formica Corp. "Formica"; Ralph Wilson Plastics Co. "Wilsonart"; Exxon Chemical Co. "Nevamar"; color as indicated in the Finish Schedule. Shall meet NEMA publication LD3 for general purpose type. Balancing sheet shall be backing sheet grade of same thickness as face sheet.

2.1.05 Particleboard. Shall be smooth surface corestock complying with ANSI A208.1 and having a minimum density of 45 lbs. per cubic foot. (720.84 kg per cu m)

2.1.06 Hardware. For the purpose of establishing the standard of quality and type desired, hardware items are specified by manufacturer's name and catalog number. The products of other manufacturers of equal quality may be used, subject to approval by the Engineer. When substitute products are proposed, submit a list of each item giving the manufacturer's name, catalog number and proposed use. Provide cabinet hardware as follows:

For each drawer:

> 1 set extension drawer slides – for drawers up to 24 inches (61.0 cm) wide - Knape & Vogt No. 1300, Grant No. 338 or Garcy No. 381; for drawers over 24 inches (61.0 cm) wide – Knape & Vogt No. 1305, Grant No. 335 or Garcy No. 382.

> 1 pull – Colonial No. 753, Stanley No. 4484 or Baldwin No. 4676, US26D.

For each drawer to be locked:

> 1 lock - Corbin Cabinet No. 0665 x 7S, Yale No. 5591 x flat strike or as approved by Chicago, MK US26D.

For each 3/4 inch (1.9 cm) thick single door - flush design:

> 1 pair hinges – Stanley No. 1585, Lawrence No. D1225 x fast pin or Hager No. 1822, 2-1/2" US26D.

> 1 pull - Colonial No. 752, Stanley No. 4483-1/2 or Baldwin No. 4674, US26D.

> 1 magnetic catch - Epco No. 541.

For each 3/4 inch (1.9 cm) thick pair of doors to be locked:

> 1 lock - Corbin Cabinet No. 0370 B x 7S, Yale No. 5591 x flat strike or as approved by Chicago, MK US26D.

1 elbow catch - Ives No. 2.

1 magnetic catch – Epco No. 541.

2.1.07 Wood Primer. Primer shall be aluminum linseed oil paint conforming to Fed. Spec. TT-P-38D or water-resisting spar varnish conforming to Fed. Spec. TT-V-121H.

2.1.08 Sealant. Sealant shall be one-part water base silicone sealing compound, Dow Corning Corp. "Trademate" Tile & Fixture Sealant, or as approved, in custom color matching color of plastic laminate or other surface to be sealed.

2.2 CABINET FABRICATION. Cabinets shall include counters and enclosures of all kinds indicated to be Architectural Woodwork. Other terms are defined in the AWI Quality Standards.

2.2.01 General. Fabricate cabinets to comply with AWI Quality Standards, Section 400, for Premium Grade, unless otherwise specified.

Requirements for materials used in labeled construction, except interior of drawers and concealed framing members shall have maximum fire hazard classification of 75 for flame spread and 125 for smoke developed, when tested in accordance with ASTM E84. Materials shall be listed in the UL "Building Materials Directory" and bear the UL classification marking or listing mark.

Details of cabinet front construction shall comply with requirements of AWI Quality Standards, Article 400-G-7, for flush inset.

2.2.02 Drawers. Provide drawer guides having proper clearance, accurately aligned to insure easy operation of drawers without binding.

2.2.03 Doors. Doors wider than 36 inches (91.4 cm) or higher than 66 inches (1.7 m) shall be 1 3/8 inches (3.5 cm) thick, solid core, flush wood doors conforming to AWI Quality Standards, Section 1300.

2.2.04 Shelves for Cabinets. Shall be adjustable, unless otherwise specified, with 5/32 inch (4.0 mm) holes at 1 9/32 inches (3.3 cm) spacing in cabinet sides for shelf supports.

2.2.05 Hardware. Shop install hardware insofar as practicable. Furnish and deliver to the building all hardware items not shop installed, complete with templates, keys, screws and hardware manufacturer's installation directions.

Provide locks for cabinet doors and drawers as indicated. Cabinets having locks that are located in the same room or space shall be keyed alike but unlike those in any other room or space and masterkeyed in accordance with the Engineer's instructions. Provide two keys with each lock and four masterkeys for each masterkey system.

2.2.06 Plastic Laminate Cabinets. Fabricate plastic laminate cabinets specified to be labeled construction of UL-labeled panel systems. Core for plastic laminate shall be 3/4 inch (1.9 cm) thick particleboard or lauan-faced veneer core plywood.

Core for countertops in which sinks occur and for backsplashes for such tops shall be exterior grade lauan-faced plywood or phenolic resin particleboard. Joint between backsplash and countertop shall be waterproof.

Apply plastic laminate face sheet to exposed surfaces of the back of doors and drawer fronts, and top of the cabinet shelves. Finish exposed edges with plastic laminate face sheet or extruded plastic molding. Face semi-exposed surfaces, including bottom of cabinet shelves, with 0.020 inch (0.5 mm) plastic laminate cabinet liner or AWI grade III overlay.

2.3 COUNTER AND APRON UNITS. Counter and apron units, including backsplashes shall be of plastic laminate construction with exposed edges finished with plastic laminate face sheets.

Cut openings in countertop in accordance with sink manufacturer's template.

2.4 LIBRARY SHELVING. Shelving shall be wood cabinets with open fixed shelves, fixed interior shelves, and trim.

Exposed trim shall be lumber for transparent finish. Exposed plywood surfaces, including entire open shelf unit and both faces of doors shall be veneered plywood for transparent finish.

Interior of cabinet, exclusive of interior door face and lumber trim shall be veneered plywood for transparent finish.

2.5 ARCHITECTURAL WOOD PANELING.

2.5.01 General. Comply with AWI "Quality Standards", Section 500A for Premium Grade. Comply with AWI Quality Standards, Section 200, requirements for Grade A.

Use architectural plywood for wood paneling.

Maximum fire hazard classification, as determined in accordance with ASTM E84 shall be 25 for flame spread and 50 for smoke developed. It shall be listed in UL "Building Materials Directory", and bear UL classification marking or listing mark.

2.5.02 High Density Construction. Core and crossbanding shall be approved by UL for untreated face veneers exceeding 34.0 pcf (544.6 kg per cu m) in density, overall thickness as indicated and solid hardwood lumber edge banding on top and bottom edges.

Face veneer shall be Natural teak/Brookline Mahogany #813/V as specified. Panels shall be good-one-side with back veneer of species and thickness to balance face veneer; marked with flitch number, panel number and total number of pieces in the flitch.

2.5.03 Wood Battens. Shall be as specified for architectural plywood and faced on exposed face and sides with hardwood veneer to match architectural wood paneling face veneer.

2.5.04 Matching. Veneer matching and panel matching shall be book match. All panels in a room shall be book matched. Flitch selection shall be as approved by Engineer, by specified manufacturer.

2.5.05 Finish. 4-coat system consisting of sealcoat, toner and two coats of clear conversion varnish, matching approved sample, flat sheen, and complying with the performance requirements of AWI "Quality Standards", Section 1500, for System TR-4, Premium Grade.

PART 3 - EXECUTION

3.1 INSPECTION. Verify adequacy of backing and support framing. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION. Comply with AWI Quality Standards, Section 1700, Premium Grade. Condition the woodwork to average prevailing humidity conditions before installing. Prior to installation of architectural woodwork, examine shop fabricated work for completion, and complete work as required, including back priming and removal of packing.

Before installing architectural woodwork items, paint surfaces abutting building construction with one coat of wood primer.

Install wood cabinets in accordance with approved Shop Drawings. Coordinate installation of countertop sinks with mechanical trade. Install the Work only when normal temperature and humidity conditions approximate the interior conditions that will exist when the building is occupied, not cold and damp, nor hot and dry.

Seal the following joints with sealant: Joints between cabinets, counters and trim pieces and vertical surfaces, including partitions and column enclosures, joints in field-applied backsplash and between backsplash and countertop and joints in countertop.

3.2.01 Architectural Wood Paneling. Install architectural wood paneling on wood grounds with concealed fasteners in strict accordance with approved Shop Drawings. Marred, defaced or otherwise damaged panels that cannot satisfactorily be repaired shall be replaced with new matching panels. Before installing wood paneling, backpaint in accordance with manufacturer's instructions. Edges trimmed or cut in the field shall be resealed immediately with WPA knot sealer or tung oil phenolic spar varnish or shellac.

Cut openings in paneling for junction boxes and other penetrations.

3.2.02 Keying System for Wood Cabinet Locks. Before final acceptance of building, set up a keying index for locks of wood cabinets installed under this Section, listing the key for each lock, and provide keys with metal tags indicating the lock for which the key was cut.

3.2.03 Protection. Protect factory finished architectural woodwork in accordance with manufacturer's directions.

3.3 MAINTENANCE.

3.4 Cleaning. Clean finished surfaces of architectural woodwork items in accordance with manufacturer's instructions.

End of Section

SECTION 06500

PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous plastic shop fabrications of custom sized and shaped cast plastic components. Materials are usually polyester or proprietary resins.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified the work of this section shall conform to the applicable portions of the following standard specifications:

ASTM (American Society for Testing and Materials) E84 - Test Method for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE. Take field measurements to verify or supplement dimensions indicated. Be responsible for accurate fit of the Work.

1.3.01 Manufacturer Qualifications. Shall be a company specializing in manufacturing products specified in this section with minimum five years documented experience.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings for each item showing details of fabrication and installation. Include data on specified component products, electrical characteristics and connection requirements.

1.4.02 Certifications. Submit product data layout and design computation sealed by a licensed Professional Engineer in the State of Michigan.

1.4.03 Samples. Submit samples of each material representing range of color and texture. Furnish instructions for care and cleaning of plastic materials.

1.5 DELIVERY, STORAGE AND HANDLING. Protect the Work by means of suitable cartons or paper bags during transportation to the Project site. Damaged items, as determined by the Engineer, shall be replaced.

1.6 WARRANTY. Warrant plastic material for vanity tops to be free of manufacturing defects for a period of 10 years.

During the warranty period, the Contractor agrees to replace the plastic material showing manufacturing defects, including labor costs.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Resin. Polyester or Vinylester with integral coloring, stain resistant to domestic chemicals and cleaners.

2.1.02 Polishing Cream. Compatible polishing cream to achieve specified sheen to gel coat.

Core framing may be used for shower stalls; most other components are fabricated of solid resin.

2.1.03 Core Framing. Refer to other Master Specification Sections in Division 6, Wood and Plastics for framing and wood blocking requirements.

2.1.04 Adhesive. As recommended by plastic material manufacturer.

2.2 PLASTIC VANITY TOPS.

2.2.01 Materials. Plastic material shall be Du Pont Co. "Corian", or as approved, homogeneous filled material containing methyl methacrylate, in color and pattern selected by the Engineer from manufacturer's standard range and having a maximum fire hazard classification of 25 for flame spread and 50 for smoke developed, when tested in accordance with ASTM E84.

Adhesives shall be as recommended by plastic material manufacturer for the application.

Sealant for caulked joints shall be silicone formulated to provide an exact color match.

2.2.02 Fabrication. Fabricate vanity tops of plastic material of thickness indicated, with joints, including corner joints, butted. Seal joints in pieces wider than 30 inches (76.2 cm) with joint adhesive.

2.3 FABRICATION. Fabricate components by mold to achieve shape and configuration. Gel coat the finish exposed surfaces smooth and polish to a flat sheen. Finish radius corners and edges. Complete any possible cutting, drilling, and fitting in components at factory prior to shipment, except sheet materials requiring site handling.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that joint preparation and affected dimensions are acceptable.

3.2 PREPARATION. Provide anchoring devices for installation and embedding. Provide templates and rough-in measurements.

3.3 INSTALLATION. Install the Work in accordance with approved Shop Drawings and manufacturer's instruction.

3.3.01 Plastic Vanity Tops. Install plastic vanity tops with adhesive and corrosion-resistant clips. Provide 1/32 inch (0.8 mm) expansion joints at 8 foot (2.4 m) spacing and seal joints indicated to be caulked with sealant.

3.4 CLEANING. Clean and polish fabrication surfaces.

End of Section

SECTION 06550

FRP LADDERS, HANDRAILS AND GRATING

PART 1 – GENERAL

1.1 SCOPE. This section covers furnishing and installing fiberglass reinforced plastic (FRP) ladders, handrails, grating and other FRP fabrications and appurtenances.

1.2 GENERAL.

1.2.01 Coordination. The work in this section shall be completely coordinated with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this section before fabrication and installation of items specified herein.

The Contractor shall provide pertinent trades with data and information for all items included under this section that are to be built into the work of other sections.

1.2.02 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

ASTM (American Society for Testing and Materials) A193/A193M – Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

ASTM A194/A194M – Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.

ASTM A276 – Specification for Stainless Steel Bars and Shapes.

ASTM D570 – Test Method for Water Absorption of Plastics.

ASTM D638 – Test Method for Tensile Properties of Plastics.

ASTM D732 – Test Method for Shear Strength of Plastics by Punch Tool.

ASTM D790 – Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

ASTM D792 – Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

ASTM E84 – Test Method for Surface Burning Characteristics of Building

Materials.

FM (Factory Mutual) – Approval Guide.

UL (Underwriters Laboratories) – Fire Resistance Directory.

WH (Warnock Hersey) – Certification Listings.

1.3 QUALITY ASSURANCE. The manufacturer of the fiberglass reinforced plastic components shall have at least 5 years of experience in the manufacture of items of similar size and quality, and shall present proof to the Engineer of successful installations involving the items under conditions similar to this project.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete specifications and drawings showing materials, properties, and details.

1.4.02 Certifications. The Contractor shall furnish a letter from the manufacturer certifying that the products have been designed in accordance with the load-bearing and deflection provisions for each size, span, and fabrication of items furnished under this section.

1.4.03 Samples. Two sets of samples shall be submitted for review in acceptable representative sizes. Samples shall be representative of construction, workmanship, appearance, and surface finish of the manufactured items which are proposed. Samples shall be from plant production.

1.4.04 Test Reports. Tests shall be performed on actual production samples demonstrating that the products conform to the stress and deflection requirements specified herein. Certified test data from these tests shall be submitted.

The Engineer may reject any item which does not meet project requirements.

1.5 DELIVERY, STORAGE AND HANDLING. All materials shall be delivered to the site to meet the installation schedules. All materials shall be stored under cover to protect them from direct sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 FRP Materials. Materials shall be as follows:

Resin:	Polyester or vinylester resin with ultraviolet inhibitors suitable for use in the specified environment.
Reinforcements:	Glass fiber with a suitable coupling agent.
Stainless steel:	ASTM A276, Type 316.
Fasteners:	Bolts: ASTM A193 B8M.
	Nuts: ASTM A194 B8M.
Washers:	Flat ANSI B18.22.1, material to match bolts.
	Lock ANSI B18.21.1, helical spring type, material to match bolts.

2.1.02 Plastic Laminate. Laminate shall be as follows:

Tensile Strength at Break	11,000 psi (75,842.8 kPa) minimum, ASTM D638
Flexural Strength	18,000 psi (124,106.4 kPa) minimum, ASTM D790
Tangent Modulus of Elasticity	900,000 psi (6,205.3 MPa) minimum, ASTM D790
Finished Thickness	Within $\pm$ 10 percent of nominal
Fasteners	AISI 18-8 stainless steel

All surfaces of plastic laminate shall be sealed with a resin layer at least 5 mils (0.1 mm) thick. Field-cut surfaces shall be recoated with resin obtained from the fabricator.

2.1.03 Pultruded Structural Grating. Minimum Physical Properties shall be as follows:

Property	Value	Test Method
Tensile Strength (ultimate)	30,000 psi (206,844 kPa)	ASTM D638
Tensile Strength (full section)	20,000 psi at 75 degrees F (137,896 kPa @ 23.8 degrees C)	ASTM D638
Shear Strength, Minimum	5,000 psi (34,474 kPa)	ASTM D732
Modulus of Elasticity	2.3×10^6 psi at 75 degrees F (15,858 MPa @ 23.8 degrees C) 1.8×10^6 psi at 125 degrees F 12,410.6 MPa @ 51.7 degrees C)	ASTM D790
Barcol Hardness	45	ASTM D2583
Water Absorption (by weight)	0.60 %	ASTM D570
Specific Gravity	1.60	ASTM D792
Flexural Strength	30 000 psi (206,844 kPa)	ASTM D790
Flexural Modulus	1.6×10^6 psi (11,031.7 MPa)	ASTM D790

2.2 GRATING. Pultruded grating shall be by MMFG, Pultrex by Creative Pultrusions, Inc. or approved equal.

Outer surfaces, cut edges, or any surfaces which are exposed to air during cure shall be finished so as to obtain complete cure of the resin without air inhibition.

Finishing of exposed surfaces shall be done by coating the surface with resin after initial cure. Upon performance of an acetone test, softening or tackiness of any surface will be considered evidence of incomplete cure.

The fiberglass grating shall be constructed from fire-retardant materials. The grating and stair treads shall have an ASTM E84 rating below 25. The grating shall be suitable for use in a marine, subtropical environment. The top surface shall be a nonskid type utilizing angular silica particles embedded in the upper portion of the grating or a concave profile.

Resin for FRP components shall be an acceptable polyester or vinylester. It shall be integrally resistant without applied coatings to ultraviolet radiation, high concentrations of hydrogen sulfide gas, solutions, and associated compounds. Compatible and equally resistant resin acceptable for shop and field sealing of cut edges shall be provided.

FRP components shall have integral colors acceptable to the Engineer and selected from standard resin colors.

The design and depth of grating shall be approved by the Engineer per manufacturer's design for the required load. The factor of safety shall be 5, based on ultimate stress. Grating shall be a minimum of 2 inches (5.1 cm) deep, and shall have a rectangular bar shape.

FRP grating shall be constructed of straight parallel bearing bars and cross bars composed of glass fiber and resin. No dry glass fibers shall be visible on any surface of bearing bars or cross bars. Bearing bars shall be spaced on 2 inch (5.1 cm) centers. Cross bars shall be spaced on 6 inch (15.2 cm) centers.

The FRP grating shall be designed to meet all applicable loads. In addition to the dead load of the grating, the grating shall be capable of supporting, at a minimum, a uniform live load of 100 pounds per square foot (488.3 kg per sq m), unless noted otherwise on the drawings, while maintaining a maximum deflection of 1/300 of the grating clear span.

The Contractor may reduce the grating clear span by the addition of intermediate support members. Additional member size and location shall be subject to acceptance by the Engineer.

Angle frames shall be continuous around the opening in order to present an even and flat support for the grating except as otherwise indicated on the construction drawings. The angles and anchors shall be detailed on the submitted shop drawings.

FRP grating shall be securely attached to supporting members and angles. Attachment to FRP supporting members shall be stainless steel with stainless steel fasteners. Each grating panel shall be attached to supporting members on the two long edges, with a minimum of two attachments each edge. All materials and incidentals required for attaching grating to angle frame and supports shall be furnished and installed under this section.

The layout of grating panels shall be coordinated with work of other sections to provide openings for approved mechanical equipment, actuators, gates, and other items which require penetrations or openings in the grating. Grating panels shall be further subdivided and supported to provide a maximum panel weight of 110 pounds (49.9 kg).

Fiberglass stair treads shall be sized as indicated on the construction drawings. Each tread shall have a solid nose and a permanent anti-skid surface as specified. The treads shall have a minimum thickness of 1 1/2 inches (3.8 cm) and shall be made of fire-retardant materials.

Where grating is indicated over an opening, it shall cover the entire opening, unless specifically noted or detailed otherwise on the construction drawings. The top surfaces of grating sections adjacent to each other shall be in the same plane.

Fiberglass plates or angles shall be installed where required to fill openings at changes in elevation and at openings between equipment and grating. Angle stops shall be installed at ends of grating to prevent grating from sliding.

PART 3 - EXECUTION

3.1 PREPARATION. Field measurement will be required for each grating installation to enable manufacturer to preassemble the grating. Check supporting members for correct layout and alignment. Verify that surfaces to receive grating are free of debris. Do not proceed with installation until defects are corrected.

3.2 INSTALLATION. All components shall be installed in full accordance with the construction drawings, the final shop drawings, and manufacturer's recommendations by mechanics skilled in the installation of this type of work.

There shall be not more than 1/8 inch (3.2 mm) clearance between the ends of the grating and the inside face of the vertical leg of the shelf angles. The horizontal bearing leg of the shelf angle shall not be less than 2 inches (5.1 cm). Ends of grating and cutouts shall be shop or field resin coated. Field coating shall conform to original manufacturer's materials and shall be in accordance with the manufacturer's recommendations. Cutouts in the grating shall be provided where required for equipment access or protrusion, including valve actuators or stems, and gate frames.

Where an area requires more than one grating section to cover the area, adjacent grating sections shall be clamped together at the 1/4 points with acceptable fasteners.

End of Section

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DIVISION 7 - THERMAL & MOISTURE PROTECTION **PAGE NO.**

SECTION 07100

WATERPROOFING
PART 1 - GENERAL

1.1 SCOPE. This section includes miscellaneous bituminous and fluid applied waterproofing and also covers the furnishing and installation of a waterproofing membrane sheet material as indicated on the drawings and specified herein.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) C836 – Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for use with Separate Wearing Course.

ASTM D41 – Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.

ASTM D43 – Specification for Coal Tar Primer Used in Roofing, Dampproofing, and Waterproofing.

ASTM D173 – Specification for Bitumen-Saturated Cotton Fabrics Used in Roofing and Waterproofing.

ASTM D226 – Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM D227 – Specification for Cold-Tar-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM D374 – Test Methods for Thickness of Solid Electrical Insulation.

ASTM D412 – Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension.

ASTM D429 – Test Methods for Rubber Property-Adhesion to Rigid Substrates.

ASTM D449 – Specification for Asphalt Used in Dampproofing and Waterproofing.

ASTM D450 – Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing.

ASTM D471 – Test Method for Rubber Property-Effect of Liquids.

ASTM D570 – Test Method for Water Absorption of Plastics.

ASTM D624 – Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

ASTM D638 – Test Method for Tensile Properties of Plastics.

ASTM D746 – Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

ASTM D751 – Test Methods for Coated Fabrics.

ASTM D822 – Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Water Exposure Apparatus.

ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

ASTM D1149 – Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber.

ASTM D1327 – Specification for Bitumen-Saturated Woven Burlap Fabrics Used in Roofing and Waterproofing.

ASTM D1505 – Test Method for Density of Plastics by the Density–Gradient Technique.

ASTM D1668 – Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.

ASTM D1693 – Test Method for Environmental Stress-Cracking of Ethylene Plastics.

ASTM D2178 – Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.

ASTM D2240 – Test Method for Rubber Property – Durometer Hardness.

ASTM D2626 – Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing.

ASTM D2822 – Specification for Asphalt Roof Cement.

ASTM D3468 – Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing.

ASTM D3747 – Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation.

ASTM D4068 – Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water Containment Membrane.

ASTM D4551 – Specification for Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water Containment Membrane.

ASTM D4637 – Specification for EPDM Sheet Used in Single Ply Roof Membrane.

ASTM E96 – Test Methods For Water Vapor Transmission of Materials.

NRCA (National Roofing Contractors Association) – Specification for Waterproofing Manual.

1.3 QUALITY ASSURANCE. Perform work in accordance with NRCA Waterproofing Manual. Test material samples in accordance with ASTM D449 or as appropriate.

1.3.01 Manufacturer’s Qualifications. Manufacturer of specified waterproofing materials shall have experience in the design and manufacture of materials specified and shall submit evidence that the proposed materials have been in satisfactory service for at least five years.

1.3.02 Installer Qualifications. Company approved by manufacturer specializing in performing work of this section with minimum three years of experience.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate flashings, control and expansion joints, locations and details, sealing at openings, projections, penetrations, reglets, and waterproofing of miscellaneous holes, slots, and sleeves. Submit manufacturer's product data, and other pertinent information. Submit special procedures and limitations requiring special attention.

1.4.02 Certifications. Certify that products meet or exceed specified requirements. The HPDE manufacturer shall submit a certification stating that the sheeting meets all the physical property requirements for the intended application.
1.4.03 Sample. Submit representative samples of waterproofing materials.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations, and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

1.6 WARRANTY. Provide three year warranty for miscellaneous waterproofing failing to resist penetration of water, except for membrane waterproofing. The manufacturer of membrane waterproofing materials shall warrant, on a pro-rata basis, the materials against leaks, manufacturing defects and material degradation for a period of 20 years from the date of final acceptance. Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

The manufacturer shall replace any material which fails due to manufacturing defects or material degradation within the warranty period. The manufacturer shall furnish the Engineer with a written warranty covering the requirements specified herein.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS.

2.1.01 Bituminous Waterproofing Materials. Provide products from Carlisle Coatings & Waterproofing, Grace Construction Products, Sonneborn Division of Chem Rex, Tremco Sealant/Weatherproofing Division, W. R. Meadows, Inc., or equal.

2.1.02 Fluid Applied Waterproofing Materials. Provide products from Carlisle Coatings & Waterproofing, Grace Construction Products, Neogard Corp., Seal-Krete Inc., Tremco Sealant/Weatherproofing Division, or equal.

2.1.03 Sheet Membrane Waterproofing Materials. Provide products from Carlisle Coatings & Waterproofing, Grace Construction Products, MiraDri Moisture Protection Products, W. R. Meadows Inc., or equal.

2.1.04 Sheet Bituminous Waterproofing. Provide Bituthene 3000 Waterproofing Membrane by Grace Construction Products, or equal.

2.1.05 Protection Board. Provide Bituthene Protection Board by Grace Construction Products, or equal.

2.1.06 Prefabricated Drainage Composite Hydroduct 220 by Grace Construction Products, or equal.

2.2 MATERIALS. Miscellaneous materials such as primer, mastic, liquid membrane, tape, and accessories shall be as specified or acceptable to manufacturer of sheet membrane waterproofing.

2.2.01 Sheet Membrane Waterproofing. High density polyethylene containing polymers and carbon, black, potable grade shall be manufactured of new, first quality products designed and manufactured specifically for the intended purpose.

The membrane material shall be so produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter. Any such defect shall be repaired using the extrusion fusion welding technique in accordance with the manufacturer's recommendations.

The HDPE material shall have the physical properties shown in the table below.

Property	Test Method	Minimum Specifications
Density, g/cm^3	ASTM D1505	0.94
Overall Thickness, mils	ASTM D374	60
Tensile Property, each direction Tensile Strength at Break, lbs/in width Elongation at Break, percent, min	ASTM D638, Type IV	 150 700
Hydrostatic Resistance, psi	ASTM D751, Method A. Procedure 1.	300
Environmental Stress Crack, hours, min	ASTM D1693	750
Ozone Resistance	ASTM D1149 (1/8 inch bent loop; 100 pphm; 104 F; 7 day	No cracks at 7 x magnification
Adhesives and Solvents		As recommended by HDPE material manufacturer
Butyl Tape		General Sealant “Type GS4
Stainless Steel Battens		ASTM A167, Type 316 or 304
Bolts		IFI-104, Grade 316 or 304
Expansion Anchors		Type 316 stainless steel; Ramset “Trubolt” or Hilti “Kwik bolts”
Thiokol Sealant		Fed Spec TT-S-00277; poly-

		sulfide rubber, two components; Pecora “GC-5”, PRC “Rubber Calk 350”, Sonneborn “Sonolastic”, or Woodmont “Chem-Calk 200”
Joint Filler		Pacific Polymers “Elasto-Deck No. 5001”, suitable for submerged service

2.3 MANUFACTURER AND FABRICATION. Individual widths of HDPE material shall be maximized to minimize field seams. There shall be no factory seams.

2.3.01 Raw Materials. All compound ingredients of the HDPE materials shall be randomly sampled on delivery to the HDPE manufacturing plant to ensure compliance with specifications. Tests to be carried out shall include Density ASTM D1505 and Melt Index ASTM D1238, Condition E.

2.3.02 Manufactured Roll Goods. Samples of the production run shall be taken and tested according to ASTM D638 to ensure that tensile strength at yield and break, and elongation at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

PART 3 – EXECUTION

3.1 INSPECTION. The installer shall inspect conditions of substrates and other conditions under which this work is to be performed and notify Contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 PREPARATION. Refer to manufacturer’s recommendations for preparation of substrates. Surfaces shall be structurally sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil, and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods, which are acceptable to manufacturer of applicable waterproofing materials. Treat joints and install flashings as recommended by waterproofing manufacturer.

3.3 INSTALLATION. Refer to manufacturer’s literature for recommendations on installation for waterproofing and related materials.

3.3.01 Bituminous Waterproofing Application. Prime surfaces in accordance with NRCA – Waterproofing Manual. Install cant strips at inside corners. Apply hot moppings of bitumen and embed reinforcement in accordance with NRCA – Waterproofing Manual.

Roll or press reinforcement firmly into bitumen eliminating wrinkles, air pockets, or disruptions of continuity. Lap edges and ends 6 inches (15.2 cm). Apply two additional plies at corners, intersections, angles, and over joints. Apply two additional plies diagonal to inside corner interruptions to membrane.

Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6 inches (15.2 cm) above horizontal surface for first ply and 4 inches (10.2 cm) at subsequent plies laid in shingle fashion. Extend membrane into drain clamp flange, apply adequate coating to mastic to assure clamp ring seal. Coordinate with drain installation.

Terminate top edge of membrane under Counterflashing, seal with mastic. Coordinate with Master Specification Section 07500, Flashing and Trim.

Continue reinforced membrane over control joints.

Seal protrusions to and penetrations through membrane with multiple plies of reinforcement and flood coating, and mastic. Seal watertight.

3.3.02 Fluid-Applied Waterproofing Installation. Apply surface conditioner at a rate recommended by manufacturer. Protect conditioner from rain or frost unit dry. Apply 12 inch (30.5 cm) wide strip of joint cover sheet over cracks and non-working joints. At expansion joints from 1/2 to 1 inch (1.3 to 2.5 cm in width, loop cover sheet down into joint between 1 1/4 and 1 3/4 inch (3.2 and 4.4 cm). Extend sheet 6 inches (15.2 cm) on either side of expansion joint.

Center cover sheet over crack or joints. Roll sheet into 1/8 inch (3.2 mm) coating of waterproofing material. Apply second coat over sheet extending minimum of 6 inches (15.2 cm) beyond sheet edges.

Install cant strip strips at inside corners.

Apply waterproofing material. Apply and spread waterproofing material to minimum 1/2 inch (1.3 cm) cured thickness, averaging 3/4 inch (1.9 cm) in thickness. Apply extra thickness of waterproofing material at corners, intersections, angles, and over non-working joints.

Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 6 inches (15.2 cm) above horizontal surface for first ply and 4 inches (10.2 cm) at subsequent plies laid in shingle fashion.

Seal items protruding to or penetrating through membrane and install Counterflashing membrane material.

Extend waterproofing material and flexible flashing into drain clamp flange, apply adequate coating of liquid membrane to assure clamp ring seal. Coordinate with drain installation.

Install membrane flashings and seal into waterproofing material.

3.3.03 Membrane Waterproofing Materials Application. The installation of the HDPE must be done by applicators certified by the manufacturer using the manufacturer's extrusion or hot wedge welding equipment and installation methods. All supervisors overseeing the liner installation must have two million (2,000,000) square feet (185,800 square meters) of supervisory liner experience. All field technicians must have over two hundred thousand (200,000) square feet (18,580 square meters) of seaming experience.

The HDPE material shall be installed in such a manner as to assure minimum handling. The membrane shall be anchored in accordance with details indicated on the drawings. The sheets shall be of such lengths and widths and shall be placed in such a manner as to reduce field jointing to a minimum.

Projections through the membrane shall be sealed in accordance with the details indicated on the drawings or in accordance with other sealing methods acceptable to the Engineer.

Individual panels of liner material shall be laid out and overlapped by a maximum of 4 inches (10.2 cm) for extrusion weld prior to welding or 5 inches (12.7 cm) for hot wedge weld prior to welding. Extreme care shall be taken by the installer in the preparation of the areas to be welded. The area to be welded shall be cleaned and prepared according to the procedures laid down by the material manufacturer. All sheeting shall be welded together by means of integration of the extrudate bead with the lining material. The composition of the extrudate shall be identical to the lining material, or all sheeting shall be welded together using hot wedge weld.

The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contract where the machine is actually fusing the lining material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap extrusion weld shall be applied.

Any weak or unbonded seams shall be repaired with a minimum 6 inch (15.2 cm) patch overlay. All membrane repair shall be made with patches having rounded corners. The installation contractor shall be responsible for all membrane repairs.

3.3.04 Protection. Protect completed membrane waterproofing from subsequent construction activities as recommended by manufacturer.

3.3.05 Cleaning. Remove any masking materials after installation. Clean any stains on materials which would be exposed in the complete work.

3.4 FIELD QUALITY CONTROL. The installation contractor shall employ on-site physical non-destructive testing on all welds.

A quality-control technician shall inspect each seam and submit an inspection report. Any area showing a defect shall be marked and repaired in accordance with HDPE repair procedure.

A test weld 3 feet (91.4 cm) long from each welding machine shall be run each day prior to liner welding and under the same conditions as exist for the liner welding. The test weld shall be marked with date, ambient temperature, and welding machine number, Samples of weld 1/4 inch (6.4 mm) to 1/2 inch (1.3 cm) wide shall be cut from the test weld and pulled by hand in peel. The weld should not peel. Seams should exhibit a film tear bond. The weld sample shall be kept for subsequent testing on laboratory tensiometer equipment in accordance with the applicable ASTM standards. Random weld samples may be removed form the installed welding sheet at a frequency to be agreed (e.g. 1/500 feet (457.2 m) of weld).

End of Section

SECTION 07110

CRYSTALLINE WATERPROOFING

PART 1 - GENERAL

1.1 SCOPE. This section covers crystalline waterproofing of concrete.

1.2 GENERAL. Crystalline waterproofing is a blend of Portland cement, fine treated silica sand and active proprietary chemicals. When mixed with water and applied as a cementitious coating, the active chemicals cause a catalytic reaction that generates a non-soluble crystalline formation of dendritic fibers within the pores and capillary tracts of concrete. This process causes concrete to become permanently sealed against the penetration of liquids from any direction.

1.2.01 Coordination. Adequate ventilation shall be provided to prevent accumulation of hazardous fumes during application of waterproof coating in enclosed spaces. Ventilation shall be maintained until work is complete and coatings have thoroughly cured.

1.3 QUALITY ASSURANCE. Primary materials shall be obtained from a single manufacturer. Secondary materials shall be provided only as recommended by the material manufacturer's representative.

Application of all crystalline waterproofing shall be done under the direction of the approved primary material manufacturer's representative.

Waterproofing application shall be by a firm that has specialized for not less than three years in installation of waterproofing and is acceptable to the manufacturer of the primary materials.

The waterproofing manufacturer’s representative shall provide technical consultation on waterproofing application.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Specifications and data covering physical properties, mixes, and application procedures shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.4.02 Certificates. Provide certificates, signed by manufacturer or manufacturer’s representative, certifying that the materials to be installed comply in all respects with the requirements of this specification and that the applicator is qualified and approved to install the materials in accordance with the manufacturer's product data.

Provide copy of report from manufacturer's representative confirming that the surfaces to which waterproofing material is to be applied are in a suitable condition to receive the coating.

1.5 DELIVERY, STORAGE AND HANDLING. All materials shall be stored in original undamaged containers with manufacturer's seals and labels intact. Materials shall be stored off the ground in a dry enclosed area.

1.6 WARRANTY. Prior to acceptance of work furnish a written certificate stating that all materials and workmanship in connection with the specified work have been furnished and installed in complete conformance with these specifications, and with the approved manufacturer's requirements for this work.

Provide a warranty, issued jointly by the manufacturer and the applicator of the waterproof coating, against moisture penetration through treated surfaces and corrosion for a period of five years.

PART 2 - PRODUCTS

2.1 MATERIALS. The waterproofing system shall be manufactured by Xypex Chemical Corporation and shall consist of Xypex concentrate or Xypex modified. Products by other manufacturers, such as Vandex Super by Aquafin, Inc. and Tegraproof by ChemRex may be acceptable depending upon application. Crystalline waterproofing products shall be obtained from a single manufacturer.

2.2 PROPORTIONING.

2.2.01 Design Mixture. Mix waterproofing material by volume with clean water which is free from salt and deleterious materials. Mix waterproofing material in quantities that can be applied within 20 to 30 minutes from time of mixing. As mixture thickens, stir frequently, but do not add additional water. Do not mix bonding agents or admixtures with crystalline waterproofing materials.

For brush application mix, measure dry powder and place in mixing container. Measure water and mix into the dry powder with a paddle on a slow speed electric drill (250 rpm) or other type mixer which is acceptable to manufacturer. Mixing proportions shall be as follows:

Coverage	Proportions (by Volume)
1.5 lb per sq yd (0.8 kg per sq m)	5 powder to 2 water
2.0 lb per sq yd (1.1 kg per sq m)	3 powder to 1 water

For spray application mix, mixing shall be the same as specified for brush application except that mixture shall be thinner. Use the following proportions as a guide only. Adjust proportions to match type of spray equipment and pressures used. Mixing proportions shall be as follows:

Coverage	Proportions (by Volume)
1.5 lb per sq yd (0.8 kg per sq m)	5 powder to 3 water

PART 3 - EXECUTION

3.1 INSPECTION. All surfaces to be waterproofed shall be examined for form tie holes and structural defects such as honeycombing, rock pockets, and cracks. These areas shall be repaired with non-shrink grout in accordance with ACI and the grout manufacturer's printed instructions.

3.2 PREPARATION. The concrete surfaces shall be cleaned of all debris, material and dirt which would inhibit adhesion of the waterproofing system.

Concrete surfaces shall have an open capillary system to provide tooth and suction and shall be clean; free from scale, excess oil, laitance, curing compounds and any other foreign matter. Horizontal surfaces shall not be troweled or power-troweled, and shall be left with a rough float finish or a broom finish. Vertical surfaces may have a sacked finish or wood form finish.

Smooth surfaces or surfaces covered with excess oil or other contaminants shall be washed, lightly sandblasted, water-blasted, or acid-etched with muriatic acid, as required to provide a clean absorbent surface. Surfaces to be acid-etched shall be saturated with water prior to application of acid.

Prior to application of waterproofing treatment, thoroughly saturate concrete surfaces with clean water as required to ensure migration of crystalline chemicals into voids and capillary tracts of the concrete. Remove free surface water before application.

3.3 INSTALLATION.

3.3.01 Application. Before proceeding with application, the Contractor shall take all necessary steps to adequately protect any and all equipment.

Apply crystalline type waterproofing in strict accordance with the approved manufacturer's instructions.

The waterproofing system shall consist of a two coat application as recommended by the manufacturer.

When brushing, a short, semi-stiff bristle brush or broom shall be used to work the slurry well into the concrete, filling all hairline cracks and surface pores.

When spraying, suitable spray equipment shall be used and the nozzle shall be held close enough to ensure that slurry is forced into pores and hairline cracks.

The second coat shall be applied while first coat is still "green" but after it has reached set as recommended by the manufacturer.

3.3.02 Curing. Curing shall begin as soon as the waterproofing materials have set up sufficiently so as not to be damaged by a fine spray. Treated surfaces shall be mist fog sprayed three times a day for a two to three-day period, or cover treated surfaces with damp burlap for the prescribed period. Allow material to set 12 days before filling the structure with liquid.

Do not lay plastic sheeting directly on the waterproofing coating as air contact is required for proper curing. If poor air circulation exists in treated areas, it may be necessary to provide fans or blown air to aid in curing of waterproofing treatment.

Protect treated surfaces from damage due to wind, sun, rain, and temperatures below 36 degrees F (2.2 degrees C) for a period of 48 hours after application. Arrange protection to permit proper curing conditions for waterproofing material.

If moist curing is not possible, use a chemical curing agent that is specifically designed for or compatible with the approved crystalline waterproofing treatment. Curing agent shall have at least two years of successful field use and shall be approved by the waterproofing manufacturer in writing.

3.3.03 Clean-up. Remove all surplus materials from the premises and leave all areas broom-clean. Sump holes shall also be cleaned. Items used for temporary protection shall be removed carefully to avoid damage to treated surfaces.

End of Section

SECTION 07120

POLYMER MONOLITHIC LINING

PART 1 - GENERAL

1.1 SCOPE. This section covers the materials and application of corrosion-resistant, spray applied, polymer monolithic lining for protection concrete surfaces subjected to corrosive and/or wastewater environments.

1.2 GENERAL.

1.2.01 Coordination. Convene pre-installation conference at the Contractor's direction prior to commencing work to review methods and sequence of installation. The meeting shall include the Engineer, Contractor and/or Subcontractor, Manufacturer's Representative, and other affected parties.

1.2.02 Governing Standards.

ASTM (American Society for Testing and Materials) C109/C109M - Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch (5. 1 cm) cube specimens).

ASTM C321 – Test Method for Bond Strength of Chemical-Resistant Mortars.

ASTM C348 - Test Method for Flexural Strength of Hydraulic-Cement Mortars.

ASTM C596 - Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.

COE CRD-C48 - Test Method for Water Permeability of Concrete; U.S. Army Corps of Engineers.

1.3 QUALITY ASSURANCE. Primary materials shall be obtained from a single manufacturer. Secondary materials shall be provided only as recommended by manufacturer's representative.

Application of all Polymer Monolithic Lining material shall be done under the direction of the approved primary material manufacturer's representative.

Installation shall be by a firm which is specialized for not less than three years in installation of waterproofing and is acceptable to the manufacturer of the primary materials. The manufacturer may require the applicator to be pre-qualified to determine qualification and skill.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit specifications and data covering physical properties, mixes, and application procedures.

1.4.02 Certifications. Submit manufacturer's certification that proposed materials, details and systems as indicated and specified fully comply with manufacturer's details and specifications. If any portion of Contract Documents do not conform to manufacturer's standard recommendations, submit notification of portions of design that are at variance with manufacturer's specifications.

1.4.03 Samples. Two samples each of the Polymer Monolithic Linings applied to concrete panels not smaller than 6 inches by 6 inches (15.2 x 15.2 cm), and indicating proposed color, thickness, and texture shall be submitted to the Engineer. After acceptance, the samples will be held to be representative of the properties and characteristics of the finally applied coating.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver materials in manufacturer's unopened containers, fully identified with brand, type, grade, class and all other qualifying information. Provide Material Safety Data Sheets for each product. Handle and protect products from moisture in accordance with manufacturer's instructions. Store off the ground and covered

Take necessary precautions to keep products clean, dry and free of damage.

1.6 WARRANTY. Prior to acceptance of work, a written certificate stating that all materials and workmanship in connection with the specified work has been furnished and installed in complete conformance with these specifications, and with the approved manufacturer's requirements for this work.

Provide a warranty, issued jointly by the manufacturer and the applicator of the waterproof coating, against moisture penetration through treated surfaces and corrosion for a period of five years.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The chemical resistant monolithic material shall be Saureisen Sewergard No. 210S. Products of other manufacturers such as Aquafin, Inc., Sonneborn, or other manufacturers may be used if performance characteristics are equal to Saureisen for protection of concrete. Water infiltration through cracks, holes or weeping must be eliminated prior to application of the polymer monolithic lining material.

The material shall meet or exceed the following properties:

Compressive Strength (ASTM C579)	6800 psi
Flexural Strength (ASTM C580)	4600 psi
Modulus of Elasticity (ASTM C580)	3.3×10^5 psi
Tensile Strength (ASTM C307)	2500 psi
Thermal exp. Coefficient	38.0×10^{-6}in/in/°F

PART 3 - EXECUTION

3.1 PREPARATION. The work shall proceed only after cleaning and repair of the substrate and all penetrating work through the substrate has been completed. The provisions of Master Specification Section 03800, Concrete Repair must be completed before the repair work can begin.

Adequate ventilation shall be provided to prevent accumulation of hazardous fumes during application of Polymer Monolithic Lining material in enclosed spaces. Ventilation shall be maintained until work is complete and coatings have thoroughly cured.

3.1.01 Surface Preparation. All structures to receive the polymer monolithic lining material must be free of laitance, dust, loose particles, oils, grease, chemical contaminants and previously applied paints or protective coatings.

Concrete surfaces that are contaminated with form oils or grease must be cleaned or scarified to remove the contaminants prior to abrasive blasting or hydroblasting to achieve hard firm surface. All active leaks must be stopped by the use of Sauereisen Insta Plug No. F-180, No. F-370 chemical grout or No. F-190 H20PRUF or approved equal material. All structural defects, voids, or cracks in substrate must be repaired prior to the polymer monolithic lining material.

3.2 INSTALLATION.

3.2.01 Application. The polymer monolithic lining material shall be applied by spray method to a thickness of 60 mils (1.5 mm). Consult Manufacturer’s Application Parameters sheet that accompanies the material for specifics on spraying fiber filled systems.

The Contractor shall consult the Manufacturer's Product Material Safety Data Sheets and container label caution statements for any hazards in handling this material.

3.2.02 Curing. Care shall be taken to prevent material from premature drying out due to sunlight or excess air movement.

Self-curing in most sewer manholes, where high humidity and cool air exists. In dry or arid areas a dissipating resin curing compound may be sprayed over the fresh applied material. Consult manufacturer for additional guidance.

Provide air circulation for 24 hours following the application in deep and/or poorly ventilated areas.

Do not allow flowing water or chemicals on the newly applied material for a minimum of 24 hours at 70 degrees F (21.1 degrees C). For temperatures below 70 degrees F (21.1 degrees C), cure a minimum of 48 hours prior to flowing water or chemical exposure.

Follow manufacturer's specifications, if poor air circulation retards curing process, to insure complete curing in enclosed spaces.

Exercise caution when temperatures exceed 90 degrees F (32.2 degrees C); call manufacturer for advice.

3.2.03 Cleaning. Remove all surplus materials from the premises and leave all areas including the floor broom-clean. Items used for temporary protection shall be removed carefully to avoid damage to treated surfaces. Assemble all such materials and remove them from the premises and follow with broom cleaning as noted.

Visual inspection should verify a uniformly treated surface.

Leaks and defective areas shall be remedied to produce a watertight installation at no additional cost to the Client.

Materials left over and any foreign material resulting from the work at the site shall be removed by applicator.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Testing. The polymer monolithic lining material should be tested for pinholes after 24 hour cure. Pinhole testing can be accomplished using a Tinker Razor Holiday Detector Model AP/W or an approved similar model.

End of Section

SECTION 07200

ROOFING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. Section includes vapor retarder, sheathing, insulation, gravel protective coating, base flashings, expansion joints and cant strips for membrane roofing. Section also includes asphalt shingle roofing, metal roofing and roof accessories.

1.2 GENERAL. Furnish all labor, equipment and materials necessary to apply the specified systems, roof insulation, flashing, accessories, wood nailers in the plane of the roof insulation, and related work as specified and as indicated.

1.2.01 Governing Standards.

UL (Underwriters Laboratories) for Wind Uplift Resistance.

U.S. Army Corp of Engineers Guide Specification 07416 (Test Method for Structural Performance of Standing Seam Metal Roof Systems by Uniform Static Air Pressure Difference).

ASTM (American Society for Testing and Materials) A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM C79/C79M – Specification for Treated Core and Non-treated Core Gypsum Sheathing Board.

ASTM C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

ASTM C208 – Specification for Cellulosic Fiber Insulating Board.

ASTM C552 – Specification for Cellular Glass Thermal Insulation.

ASTM C578 – Specification for Rigid, Cellular Polystyrene Thermal Insulation.

ASTM C612 – Specification for Mineral Fiber Block and Board Thermal Insulation.

ASTM C726 – Specification for Mineral Fiber Roof Insulation Board.

ASTM C728 – Specification for Perlite Thermal Insulation Board.

ASTM D41 – Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.

ASTM D146 – Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.

ASTM D226 – Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM D249 – Specification for Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules.

ASTM D312 – Specification for Asphalt Used in Roofing.

ASTM D1227 – Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.

ASTM E1680 – for Air infiltration Pressure Differential Test.

ASTM D1863 – Specification Mineral Aggregate Used on Built-Up Roofs.

ASTM D2178 – Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.

ASTM D2626 – Specification for Asphalt-Saturated and Coated Organic Felt Base Sheet Used in Roofing.

ASTM D2822 – Specification for Asphalt Roof Cement.

ASTM D3018 – Specification for Class A Asphalt Shingles Surfaced with Mineral Granules.

ASTM D3462 – Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules.

ASTM D3909 – Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules.

ASTM D4601 – Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing.

ASTM D4586 – Specification for Asphalt Roof Cement, Asbestos-Free.

ASTM D4897 – Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing.

ASTM E96 – Test Methods for Water Vapor Transmission of Materials.

AWPB (American Wood Preserves Bureau) LP-2 – Softwood Lumber, Timber and Plywood, Pressure Treated with Water-Borne Preservatives for Above-Ground Use.

FM DS 1-28 (Factory Mutual) – Insulated Steel Deck Construction.

NRCA ML 102 (National Roofing Contractors Association – Roofing and Waterproofing Manual.

UL (Underwriters Laboratories, Inc.) – Building Materials Directory.

UL – Fire Resistance Directory.

UL 790 – Tests for Fire Resistance of Roof Covering Materials.

WH (Warnock Hersey) – Certification Listings.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturers Qualifications. Companies specializing in manufacturing products specified in this section with minimum three years experience.

1.3.02 Contractor Qualifications. Roofing systems shall be applied by a licensed installer properly trained and equipped to apply roofing system in strict accordance with the procedures specified by the manufacturer of materials and having a minimum of five years experience in performing work of this section.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete layout drawings of each item showing details of fabrication and installation. Include items such as fastening or adhering detail, stapled insulation, showing thickness and pitches, preformed cant strips and other pertinent data, with certified materials lists.

Submit manufacturer's written technical information and installation instructions which demonstrate that materials to be installed comply with contract documents.

Submit recommendations of roofing membrane manufacturer regarding use of slip sheets.

1.4.02 Certifications. Submit a letter of acceptance of the roofing system and design, and roofing insulation type and manufacturer, by the roofing membrane manufacturer.

Submit a letter of acceptance of the roof deck surface conditions by the Roofing subcontractor.

1.4.03 Samples. Submit two samples each of proposed materials for approval or for verification of finish and color selection. Submit 3 pound (1.4 kg) minimum samples of gravel materials.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact. Store products in weather protected environment, clear of ground and moisture. Protect foam insulation from direct exposure to sunlight.

1.6 WARRANTY. Submit manufacturer's standard warranty guaranteeing to correct failures in product for 10 years from final acceptance, which may occur during the warranty period. Warranty shall not reduce or otherwise limit any other rights to correction, which the Owner may have under the contract documents.

Materials and workmanship involved in the application of the roofing system shall be guaranteed on a single document by the manufacturer of materials and the licensed installer. Guarantee shall insure waterproof performance of the roofing system for a period of ten years.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Contractor shall take field measurements to verify or supplement dimensions indicated prior to starting work.

Before starting installation work complete substrate installation including roof penetrations. Substrate shall be smooth, dry, securely anchored, and free of construction debris.

Follow manufacturer's instructions regarding acceptable weather conditions for installation of all roofing materials and accessories.

Provide products which are recommended by manufacturers to be fully compatible with indicated substrates, or provide separation materials as required to eliminate contact between incompatible materials.

2.2 ACCEPTABLE MANUFACTURERS. Roofing products from the following manufacturers that comply with requirements of the contract documents are considered acceptable:

CertainTeed Corporation.

Firestone Building Products Company.

GAF Building Materials Corporation.

Johns Manville

Architectural Metal Systems

Berridge Manufacturing Company

Metl-Span

GS Roofing Products Company, Inc.

Georgia-Pacific Corporation.

Koppers Industries.

Owens-Corning Fiberglass Corporation

Or approved equal.

Acceptable membrane roof manufacturers, if they comply with contract documents, include Carlisle SynTec Incorporated, Firestone Building Products Co., Johns Manville, and approved equals.

2.3 MATERIALS.

2.3.01 Built-up Asphalt Roofing. Use Asphalt-Saturated Organic Felts that comply with ASTM D226, No. 15, 20, 30; unperforated/perforated or Glass Fiber Felts per ASTM D2178, Type III, IV, VI.

Base Sheeting shall comply with ASTM D2626 for No. 43 plain; ASTM D4601 for Type I, II, unperforated; ASTM D4897 for vented or asphalt saturated and coated inorganic base sheet.

Mineral Surfaced Felts shall be ASTM D3909, white or black colored mineral granules.

Dry Sheathing Paper shall be clean, white cellulose, red, rosin paper, and unsaturated.

Asphalt Bitumen shall be ASTM D312 Type IV.

Asphalt Primer shall be ASTM D41

Plastic Cement shall be ASTM D4586 or ASTM D2822 Type I, II, cutback asphalt type.

Asphalt Emulsion shall be ASTM D1227 Type I, II.

Insulation shall be ASTM C208, Type II cellulose fiber board, one or both faces finished with mineral fiber, asphalt and craft paper per ASTM C728, expanded perlite mineral aggregate board or approved alternative material.

Flexible Flashings shall be EPDM, Butyl, Neoprene, or Modified bitumen.

Control or Expansion Joint Flashing shall be sheet butyl, metal counterflashings or wood materials.

Walkway Pads shall be asphalt impregnated mineral boards with granular surfaces.

2.3.02 Membrane Roofing. Single-Ply Roofing Membrane shall be ethylene propylene diene monomers (EPDM) formed into uniform, flexible sheets, formulated for loose laid, ballasted application, and complying with the following:

Tensile Strength (ASTM D 412): 1400 psi (9652.7 kPa).

Ultimate Elongation (ASTM D 412): 300 percent.

Brittleness Temperature (ASTM D 746): 75 degrees F (-59 degrees C).

Tear Resistance (ASTM D 624): 125 lbs. per inch (22.3 kg per cm).

Resistance to Ozone aging (ASTM D 573): Maximum reduction in elongation of 30 percent, maximum loss of tensile strength of 15 percent (168 hours at 240 degrees. F (116 degrees C)).

Thickness: 60 mils (1.5 mm), nominal.

Color: Manufacturer's standard.

Fire ratings, Underwriter's Laboratories Inc., Class A when applied to noncombustible deck.

2.3.03 Metal Roofing. Metal roofing shall be factory painted galvanized steel aluminum alloy not less than 20 USS gauge (1.0 mm) thick. Panels shall be continuous from ridge to eave and down the facia, and shall include all flashings, closures and gutter system, as directly related to the metal roof. Material shall be by a manufacturer acceptable to the Engineer. Metal roofing panels shall have two (2) major corrugations 2 inches high (2 ¾” inches including seam).

Galvanized steel for metal roofing shall conform to ASTM Designation A-446 Grade A having a minimum yield strength of 33,000 psi (227.5 m MPa). The unit design stress shall not exceed 20,000 psi (137.9 MPa). Zinc coating for sheets shall be by the hot-dipped process in accordance with ASTM Designation A446-64T, 1.25 oz (35 g) coating class.

Fasteners shall be self-tapping stainless steel screws installed with metal and neoprene washers to assure watertight conditions.

Sealer for side laps and flashing shall be an approved type pressure sensitive tape. The sealer shall be non-asphaltic, non-shrinking, non-drying, non-toxic and shall have excellent adhesion to metals, plastic and painted surfaces from –10 degrees to + 140 degrees F (-23.3 degrees to 60 degrees C).

Flashing shall be provided at eaves, ridge and at roof openings. Flashing shall be of same gauge and finish as roofing sheets.

Preformed rubber or neoprene closures matching the profile of the roof panels shall be installed along ridge, roof opening flashings, rake and/or eave where required for weather tightness

2.3.04 Asphalt Shingle Roofing. Asphalt shingle roofing shall meet the following:

Be mineral-surfaced, self-sealing, glass fiber base.

Comply with ASTM D3018, Type I, and ASTM D3462.

Fire resistance: Class A, UL labeled.

Type: Square, dimensional shingle.

Color: As selected by Engineer, after contract award, from manufacturer's standard colors.

Be factory prefabricated or field fabricated hip and ridge shingles to match field shingles, at contractor's option.

Design Standard: CertainTeed, New Horizon Shingle.

Underlayment: Asphalt-saturated organic roofing felt, ASTM D226, No. 15 imperforated, Type I, 36 inch (91.4 cm) wide-rolls.

Be UL listed material approved for use in roofing assembly to achieve specified fire rating.
Be factory prefabricated or field fabricated hip and ridge shingles to match field shingles, at contractor's option.

Design Standard: CertainTeed, New Horizon Shingle.

Underlayment: Asphalt-saturated organic roofing felt, ASTM D226, No. 15 imperforated, Type I, 36 inch (91.4 cm) wide-rolls.

Be UL listed material approved for use in roofing assembly to achieve specified fire rating.

2.3.05 Ice Protection Underlayment. Ice protection underlayment shall be rubberized asphalt sheet membrane, self-adhering, minimum 40 mils (1.0 mm) thick, 36 inch (91.4 cm) wide rolls; minimum tensile strength 250 psi (1723.7 kPa), in accordance with ASTM D146.

2.3.06 Fasteners. Use nails or staples at contractor's option.

Nails shall be 11 or 12 gage (2.8 to 3.1 mm), aluminum or hot-dipped galvanized, with barbed shanks, minimum 3/8 inch (9.5 mm) diameter head; length as necessary to penetrate through sheathing, or 3/4 inch (1.9 cm) into solid decking.

Staples shall be 16 gage (1.6 mm) minimum galvanized steel; crown width 15/16 inch (2.4 cm), minimum; length as necessary to be driven into decking or sheathing 3/4 inch (1.9 cm), minimum.

2.3.07 Accessories. Ridge and Hip Vents shall be Cor-A-Vent, V400 or approved equal.

Eave Vent shall be Cor-A-Vent, V400T or approved equal.

Sheet seaming system shall be manufacturer's standard materials for sealing lapped joints, including edge sealer to cover exposed spliced edges as recommended by manufacturer of roofing system.

Flashing accessories shall be types recommended by manufacturer of material, provided at locations recommended by manufacturer including adhesive tapes, flashing cements, and sealants.

Slip Sheet shall be type recommended by manufacturer of material for protection of membrane from incompatible substrates, if required by manufacturer.

Aggregate surface ballast shall be washed, rounded riverbed gravel or other acceptable smooth-faced stone ranging in size from 3/4 inch to 1 1/2 inch (1.9 to 3.8 cm) in diameter, which will withstand weather exposure without significant deterioration. Amount of ballast shall be as recommended by manufacturer.

Insulation shall be ASTM C612, Class 1 glass fiber rigid board, top surface coated with 28 lb/100 sq ft (136.7 kg/sq m) asphalt and Kraft paper.

Board edges shall be square shiplapped.

Insulation board shall be rigid glass fiber composition with bonded asphalt/paper cap sheet. Average "C" factor 0.27 Btu/hr./sq. ft./degrees F/ inch (0.6 Watts/sq m/deg C/cm) of thickness. Provide 3 1/4 inch (8.3 cm) thickness minimum comprised of a minimum of 2 layers. Insulation shall be selected by the manufacturer and submitted for approval.

Tapered insulation board shall be where indicated or where required to achieve positive drainage, and where required to form saddles or crickets, provide tapered insulation board of the same composition as above specified, but formed with 1/4 inch per foot (2.1 cm per m) taper. System shall be a completely designed combination of layers of uniform thickness boards and tapered boards, including corners, to provide positive drainage to roof drains. System shall have minimum R values as specified at its thinnest point. Tapered insulation system shall be selected by the manufacturer and submitted for approval.

If required by roofing manufacturer, cant strips shall be asphalt-impregnated fiberboard, Fed. Spec. LLL-I-535B, Class C, with contact surfaces sealed to retard bitumen absorption and height as required with 3 inch (7.6 cm) minimum face dimension.

Adhesive for bonding insulation shall be type recommended by insulation manufacturer and complying with fire resistance requirements.

Flashing material shall be manufacturer's standard system compatible with flexible sheet membrane.

Wood nailers shall be preservative treated wood nailers in the plane of the roof insulation as a part of the work of this section. Locations of nailers shall be in strict compliance with roofing membrane manufacturer's recommendations, and upper surface shall be flush with insulation surface.

Sheathing adhesive shall be non-combustible type, for adhering gypsum sheathing to metal deck.

Other sheathing fasteners may be used if they are appropriate for purpose intended and approved by Factory Mutual, system manufacturer, and Engineer.

Sheathing joint tape shall be heat resistant and self adhering paper.

Strip Reglet Device shall be galvanized steel, extruded plastic with maximum possible lengths per location.

Insulation joint tape shall be asphalt treated, self-adhering, glass fiber reinforced, 6 inches (15.2 cm) wide.

Insulation fasteners shall be appropriate for purpose intended and approved by Factory Mutual and System manufacturer. Fasteners shall have washers and penetrate through insulation and into deck but not through deck.

Roofing nails shall be galvanized, hot dipped Non-Ferrous type, size and configuration as required to suit application.

2.3.08 Fluorocarbon Enamel Color Finish for Metal Roofing. The exterior surfaces of the galvanized steel sheets of the metal roofing and associated metal items including flashings, closures, and other items which form parts of the roof installation shall be finished with a colored factory applied oven baked protective finish having a basic material fluorocarbon polymeric liquid resin such as “Kynar 500” polyvinylidene fluoride) by Pennwalt Corporation, or equivalent material by Dupont or others. Use an enamel such as Fluropon by Desoto, Inc., Chemical Coatings Div.; Nubelar by Glidden-Durkee Div., SCM Corp; Duronar by PPG Industries, Inc.; or another durable and decorative architectural finish from an approved, licensed manufacturers:

Color of exterior surfaces of the various members shall be as selected by the Engineer. Exposed surfaces shall be of consistent color and shade. Any item varying in color shall be replaced as directed by the Engineer without additional cost to the Owner.

All metals to be coated shall have the surfaces carefully prepared for painting on continuous process coil coating equipment by thorough cleaning and application of a chemical conversion coating system recommended by the coating manufacturer.

The prepared metal sheets shall be given a prime coat of an appropriate primer recommended by the coating manufacturer and compatible with the finish coat. Apply primer to a dry film thickness of 0.2 mil (0.005 mm) minimum and 0.4 mil (0.01 mm) maximum. The prime coat shall be fully cured by oven baking prior to application of the finish coat color.

The colored finish coating shall be applied to the primed galvanized steel sheets to a dry film thickness of 0.7 mil (.02 mm) minimum and 1.3 mil (.03 mm) maximum, and oven baked at a temperature recommended by the coating manufacturer.

All color coated metal items shall have epoxy based prime paint, as previously specified, applied to reverse side.

All prime coatings and finish color coatings shall be applied to the metal in its coil form on a continuous process coil coatings line prior to fabrication. Coatings of items already fabricated into the required profiles will not be allowed, however, component configurations not capable of post-forming from coated coil sheets may be spray coated. All finished surfaces shall be smooth, essentially free of flow lines, streaks, blisters and other surface imperfections.

2.3.08 <u>Roof Hatches</u>. Provide roof hatches by Bilco Co., New Haven, CT; Babcock Davis Associates, Inc.; Arlington, MA; Inryco, Inc., Milcor Div., Milwaukee, WI; or approved equal.

Provide 0.0907 inch (2.3 mm) thick sheet aluminum cover with 3 inch (7.6 cm) beaded flange welded and ground smooth and 1 inch (2.5 cm) thick fiberglass insulation protected by 0.040 inch (1.0 mm) thick sheet aluminum liner.

Provide 0.0907 inch (2.3 mm) thick sheet aluminum curb formed with 3 1/2 inch (8.9 cm) flange with holes for securing curb to roof deck, and integral cap flashing of same materials. Curb of welded construction with all welds ground smooth. Watertight 1 inch (2.5 cm) thick rigid fiberboard insulation around curb.

Match with heavy pintle hinges, compression spring operators enclosed in telescopic tubes, positive snap latch with run handles, padlock hasps inside and out, and neoprene draft seal. Provide automatic hold-open arm complete with vinyl grip handle. All hardware zinc plated.

2.3.10 Prefabricated Metal Roof Curbs. Provide metal roof curbs manufactured by Custom Curb, Inc; The Pate Co., Roof Products & Systems Corp; Thycurb Div. of Thybar Corp; or approved equal.

Fabricate curbs of 14 gage (2.0 mm) steel sheet, all welded construction, fitted with 2 x 4 inch (5.1 to 10.2 cm) treated wood nailer and 1 1/2 inch (3.8 cm) rigid glass fiber insulation. Provide 22 gage (0.9 mm) steel liner. Verify size of curbed opening with equipment supplier. Prime paint or hot-dip galvanize curbs and liners after fabrication.

2.3.11 Prefabricated Equipment Supports. Provide supports for insulated roof decks, as manufactured by Custom Curb, Inc; The Pate Co; Roof Products & Systems Corp; Thycurb Div. of Thybar Corp; or approved equal.

Fabricate shell, base plate and counterflashing of 18 gage (1.3 mm) galvanized steel sheet shall comply with ASTM A653, commercial quality, G90 coating designation, welded with mitered ends, welded areas coated with zinc rich paint.

Wood nailers shall be pressure treated in accordance with AWPB standard LP-2.

2.3.12 Stack Flashing Fittings. Provide type recommended by roofing manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION. Identify obstructions on roof, which will receive substrate. Repair or replace unacceptable work which may affect proper material installation.

3.2 PREPARATION. Remove projections and debris from substrate and secure all vent stacks, curbs, and other penetrations to substrate before starting roofing work.

3.3 INSTALLATION. Install each item in accordance with manufacturer’s instructions, approved Shop Drawings, and specified requirements. Furnish each item with required fasteners.

3.3.01 Membrane Roofing and Flashing. Apply insulation and roofing membrane on fully cured, dry clean concrete roof decks. Apply tapered insulation (where shown or required) wood nailers, roofing membrane, flashings, and ballast. Apply all materials in strict accordance with manufacturer's printed instructions.

Apply primer to concrete slab as recommended by adhesive manufacturer. Embed first layer of insulation in full mopping of adhesive. Lay insulation in ashlar pattern with mopping surface up and joints snug. Apply second layer in full bed of adhesive, staggering joints in both directions and minimum of 12 inch (30.5 cm) from layer below. Keep ultimate top surface completely free of adhesive.

Embed tapered insulation, where indicated, or required, in full application of adhesive. Lay insulation in the sequence indicated by the layout drawings with joints staggered and edges of blocks butted together to form smooth, positive slopes to drains.

Do not install more insulation each day than can be covered with membrane before end of day and before start of inclement weather.

Trim surface of insulation as necessary at roof drain so completed surface is flush with ring of drain. Extend roofing into sump of roof drain in compliance with manufacturer's instructions. Secure clamps in position over membranes.

Start installation of membrane only in presence of manufacturer's technical representative.

Install membrane by unrolling over prepared substrate, fastening at perimeter and at roofing penetrations. Lap adjoining sheets as recommended by roofing membrane manufacturer and bond as recommended by manufacturer, covering top edges of each sheet at seams with uniform fillet of sealant if recommended by manufacturer. Install flashings and counterflashings as shown and as recommended by manufacturer. Apply ballast course in uniform thickness at rate recommended by the membrane manufacturer, spreading with care to minimize possibility of damage to membrane. Provide flashings as indicated on the drawings and detailed in Standard Details.

3.3.02 Built-up Asphalt Roofing.

Wood Deck: Verify flatness and tight joints of wood decking. Seal joints of plywood with tape if a hot bitumen application is to follow. Fill knot holes with latex filler.

Lay one ply of dry sheathing paper; lap edges 2 inches (5.1 cm). Lay asphalt coated base sheet; lap edges 4 inches (10.2 cm). Nail laps 9 inches (22.8 cm) oc. Nail the field area in two rows at 18 inches (45.7 cm) oc staggered.

Two plies of roof felt may also be utilized over separator sheet; lap plies 19 inches (48.3 cm) and nail at 12 inches (30.5 cm) oc along seams. Mop surface with hot bitumen and embed two plies, one ply of roof felt; lap plies 19 inches (48.3 cm), full mop each ply. Apply bitumen at 20 lb/100 sq ft (97.6 kg/100 sq m).

Extend vapor retarder under cant strips and blocking.

Install flexible flashings from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

Glaze top surface of the vapor retarder if insulation is not placed immediately.

Concrete Deck: Fill surface honeycomb and variations with latex filler.

Apply primer at a rate of 1 gal/100 sq ft (40.7 L/100 sq m) and allow to dry.

For vapor retarder, mop surface with hot bitumen and embed two plies of roof felt, full mop each ply; lap plies 19 inches (48.3 mm); apply bitumen at a rate of 20 lb/100 sq ft (97.6 kg/100 sq m).

Lap flexible flashings over air seal material of wall construction to provide continuity of the air barrier plane.

Glass top surface of the vapor retarder if insulation is not placed immediately.

Metal Deck without Gypsum Sheathing: Install preformed sound absorbing glass fiber insulation strips in acoustic deck flutes.

Apply fire resistant vapor retarder to deck surface with adhesive in accordance with manufacturer’s instructions.

The acceptability of applying gypsum sheathing to steel roof decks will be determined by local codes, UL, or FM requirements.

Metal Deck with Gypsum Sheathing: Install gypsum sheathing on metal deck. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.

Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface. Tape joints to provide secure structure.

Mechanically fasten sheathing using approved fasteners with washers on each sheathing board.

Apply fire resistant vapor retarder to deck surface with adhesive in accordance with manufacturer’s instructions.

3.3.03 Insulation. Ensure vapor retarder is clean and dry, continuous, and ready for application of roofing system.

Mechanically fasten first layer of insulation to deck. Embed a second layer of insulation into flood coat mopping of hot bitumen. Lay second layer of insulation with joints staggered from first layer.

Tapered insulation in single or multiple thicknesses, depending on the insulation system selected.

Place boards parallel or perpendicular to deck flutes with insulation board edges bearing on deck flutes respectively. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof. Lay tapered boards, cut boards to slop minimum 18 inches (45.7 cm) back from roof drains for positive drainage. Do not apply more insulation than can be covered with membrane in same day. Joint taping is used when recommended by insulation manufacturer.

When two layers of insulation are required, place the second layer of insulation with joints staggered minimum 6 inch (15.2 cm) from joints of first layer.

For insulation placed over flat surfaced or sheathed decks, mechanically fasten boards from roof edge to cover roof surface. Ensure that fasteners do not pierce through roof deck.

For placing insulation over unsheathed fluted metal deck surfaces, place fasteners in each insulation board. Ensure that fasteners do not pierce through roof deck.

Tapered insulation in single or multiple thickness, depending on the insulation system selected, require placement of the constant thickness first layer and the tapered thickness insulation second layer to be in a sloped pattern.

Place boards in unsheathed metal decking parallel or perpendicular to deck flutes with edges over flute surface for bearing support. Lay board with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof. Lay tapered boards, cut boards to slope for a minimum distance of 18 inches (45.7 cm) back from roof drains for positive drainage. Do not apply more insulation than can be covered with membrane in same day. Tape joints of insulation if recommended by insulation manufacturer.

3.3.04 Roof Felt Plies. The optional ply may count as one ply in a three or four ply roof system. A coated base sheet may be used where the deck or substrate is less than ideal. Lay one ply coated base sheet, coated side down. Lap sides 2 inches (5.1 cm); lap ends 6 inches (15.2 cm).

Apply a minimum of 3 plies of roof felt over coated base ply, weather lap edges and ends, mopped with 20 lbs/100 sq ft (97.6 kg/100 sq m) of bitumen per ply. Apply felt in same opposing directions.

Apply felts smooth, free from air pockets, wrinkles, fish-mouths, or tears.

Extend base ply and membrane felts up cant strips a minimum of 4 inches (10.2 cm) onto vertical surfaces and under gravel stops. Mop on two additional plies of felt and one ply of granular surfaced felt as base flashings over roofing membrane plies. Secure to nailing strips at 4 inches (10.2 cm) on center and at reglets.

Install two plies membrane and bitumen glaze coat for cut-off at end of day's operation. Glaze felts exposed at end of working day. Remove cutoff before resuming roofing.

Mop and seal two additional plies of felt around roof penetrations.

3.3.05 Traffic Pads. Install traffic pads by setting in hot asphalt at 20 lb per 100 sq ft (97.6 kg per 100 sq m) cold mastic at 2 gallon per sq ft (81.5 L per sq m) Set joints 6 inches (15.2 cm) apart.

3.3.06 Flashing Accessories. Verify compatibility of flashing materials with roofing system materials. For flashing and accessories installation, apply granular surfaced felt flexible base flashings to seal membrane to vertical elements.

Install prefabricated or fabricated roofing control and expansion joints to isolate roof into areas as indicated. Make joints watertight.

Coordinate installation of roof drains, sumps and related flashings to drawings.

Mop in and seal flashings and flanges of items penetrating membrane with two plies of felt.

Not less than 400 lb per 100 sq ft (1,953.1 kg per 100 sq m) should be used for the single application. Not less than a total of 600 lb per 100 sq ft (2,929.6 kg per 100 sq m) of aggregate should be used for the double application.

For aggregate multiple surfacing installations, apply uniform flood coat of bitumen at rate of 60 lb per 100 sq ft (293.0 kg per 100 sq m) and while hot, embed a single application of roofing aggregate at rate of 400 lb per 100 sq ft (1,953.1 kg per 100 sq m).

Apply cap sheet, if required, in accordance with manufacturer's recommendations.

3.3.07 Metal Roofing. The metal roofing manufacturer shall be fully responsible for the installation of work specified in this section. Installation shall be performed by trained mechanics of the manufacturer or by a duly authorized agent of the manufacturer. No installation of the metal roofing shall commence until the installation subcontractor has been reviewed by the Engineer.

Roof panels shall be laid continuous where possible from ridge to eave with ribs standing and sidelaps and endlaps sealed with a continuous ribbon of tape sealer. Fasten panel units securely to each supporting member with self-tapping screws. All sidelaps and endlaps shall be fastened together through the high flat of the rib with sheet metal screws.

Ends of adjacent roof sheets shall be staggered on supporting members so that ends are not terminated on any one supporting member except at roof edges or at roof openings.

Roof sheets shall start and terminate at the center of supporting member at ends of runs.

Spacing of all fasteners shall be as recommended by the metal roofing manufacturer for the type of roofing provided. All exposed fasteners shall have colorful caps or heads matching color of panels.

Install all trim including flashings and closures to construct a neat appearance and watertight installation. Install gutters and downspouts for free drainage to the paving slab below.

3.3.08 Shingle Installation. Install shingles in accordance with shingle manufacturer’s instructions or NRCA’s “The NRCA Steep Roofing Manual,” whichever is more restrictive.

Lay out work with horizontal and vertical chalk lines.

Apply one layer of felt horizontally over substrate, with 2 inch (5.1 cm) minimum side laps and 4 inch (10.2 cm) minimum end laps. Secure with roofing nails until shingles are installed.

Install self-adhering ice protection underlayment along full length of eaves from the eave edge to a point 24 inch (61.0 cm) minimum beyond wall line in accordance with underlayment manufacturer’s installation instructions.

Install the following types of flashings and edge protection, to conform with installation details and instructions of “The NRCA Steep Roofing Manual” and to provide a weathertight installation:

Install step flashing at vertical wall for entire length of intersection of roof surface and vertical wall.

Start asphalt shingle installation with row of inverted shingles without tabs or layer of roll roofing placed along full length of eave and fastened. Cutouts to break joints on thirds with shingle course below.

Contractor shall review with Engineer shingle manufacturer's instructions for type of shingles specified.

3.3.09 Prefabricated Metal Roof Curbs. Attach prefabricated curbs to wood nailer on roof deck with wood screws.

Weld prefabricated curbs to metal roof deck or bolt prefabricated curbs to concrete roof deck.

3.3.10 Protection. Where traffic must continue over finished roof membrane, protect surfaces.

3.3.11 Cleaning. Remove construction debris from roof surfaces and clean out gutters and downspouts. Remove bituminous markings from finished surfaces.

In areas where finished surfaces are soiled by bitumen or other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions. Repair or replace defaced or disfigured finishes caused by work of this section.

3.4 FIELD QUALITY CONTROL. Require roofing and insulation manufacturers to visit site daily during installation of the work.

3.5 MAINTENANCE. Furnish 5 bundles of each asphalt shingle type and color used in the work.

End of Section

SECTION 07210

THERMAL PROTECTION AND BUILDING INSULATION

PART 1 - GENERAL

1.1 SCOPE. This section covers vapor and air retarders, board insulation, batt insulation, loose glass fiber insulation and foamed-in-placed insulation. Refer to the drawings for insulation locations.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) C208 – Specification for Cellulosic Fiber Insulating Board.

ASTM C240 – Test Methods of Testing Cellular Glass Insulation Block.

ASTM C552 – Specification for Cellular Glass Thermal Insulation.

ASTM C578 – Specification for Rigid, Cellular Polystyrene Thermal Insulation.

ASTM C612 – Specification for Mineral Fiber Block and Board Thermal Installation.

ASTM C665 – Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

ASTM C764 – Specification for Mineral Fiber Loose-Fill Thermal Insulation.

ASTM D2103 – Specification for Polyethylene Film and Sheeting.

ASTM D2842 – Test Method for Water Absorption of Rigid Cellular Plastics.

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

NFPA 255 (National Fire Protection Association) – Test of Surface Burning Characteristics of Building Materials.

UL 723 (Underwriters Laboratories, Inc.) – Tests for Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE.

1.3.01 Thermal Resistivity. Where thermal resistivity properties of insulation materials are designated by r-values they represent the rate of heat flow through a homogenous material exactly 1 inch (2.5 cm) thick, measured by test method included in referenced material standard or otherwise indicated. They are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.3.02 Fire Performance Characteristics. Provide insulation materials which are identical to those whose fire performance characteristics, as listed for each material or assembly of which insulation is a part, have been determined by testing, per methods indicated below, by UL or other testing and inspecting agency as acceptable to authorities having jurisdiction.

Surface Burning Characteristics: ASTM E84
Fire Resistance Rating: ASTM E119
Combustion Characteristics: ASTM E136

1.3.03 Sample Construction. Install samples of each type of insulation in appropriate locations a minimum of 8 feet (2.44 m) wide, full height, for approval of workmanship. Approved sample construction shall be a standard of workmanship for the Project and may remain in place.

1.4 SUBMITTALS.

1.4.01 Drawings and Product Data. Submit manufacturer product literature and installation instructions for each type of insulation and vapor retarder material required.

1.4.02 Certifications. Submit installer certificates signed by manufacture certifying that exterior finished system insulation installer complies with specified requirements.

1.4.03 Samples. Submit samples of each type of insulation to be installed.

1.4.04 Test Reports. With product data, submit copies of certified test reports showing compliance with specified performance values, including R-values (aged values for plastic insulations), densities, compression strengths, fire performance characteristics, perm ratings, water absorption ratings and similar properties.

Submit a statement of compliance and compatibility for miscellaneous accessory materials, including sealants, adhesives, tapes and all other similar materials.

1.5 DELIVERY, STORAGE AND HANDLING. Protect insulation materials from physical damage and from becoming wet, soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation.

Do not expose plastic insulation to sunlight, except to extent necessary for period of installation and concealment. Protect against ignition at all times. Do not deliver plastic insulating materials to project site ahead of installation time. Complete installation and concealment of plastic materials as rapidly as possible in each area of work.

1.6 PROJECT CONDITIONS. Environmental Conditions: Do not install system when ambient outdoor temperatures are 40 degrees F (4.4 degrees C) and falling unless temporary protection and heat is provided to maintain ambient temperatures above 40 degrees F (4.4 degrees C) during installation of wet materials and until they have dried thoroughly and become weather resistant, but for not less than 24 hours after installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS.

2.1.01 Insulation. Subject to compliance with requirements, provide general insulation products from Amoco Foam Products Co., Dow Chemical U.S.A., Johns Manville, CertainTeed Corp., Owens-Corning Fiberglass Corporation, or approved equal.

2.2 MATERIALS. Provide insulating materials which comply with requirements indicated for materials, compliance with referenced standards, and other characteristics.

Preformed Units shall be in sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths and lengths.

2.2.01 Extruded Polystyrene Board Insulation. Rigid, cellular thermal insulation with closed-cells and integral high density skin, formed by the expansion of polystyrene base resin in an extrusion process to comply with ASTM C578; with 5-year aged r-values of 5.4 and 5 at 40 degrees and 75 degrees F (4.4 degrees and 23.9 degrees C), respectively; and be Type IV, 1.6 lb per cu ft (25.6 kg per m^3) minimum density, unless otherwise indicated. Surface Burning Characteristics for flame spread and smoke developed values shall be 5 and 165 maximum, respectively.

2.2.02 Isocyanurate Board Insulation. Rigid, cellular thermal insulation with glass-fiber-reinforced isocyanurate closed-cell foam core and aluminum foil facing laminated to both sides; complying with FS HH-I-1972/1, Class 2; aged r-values of 7.2 and 8 at 40 and 75 degrees F (4.4 and 23.9 degrees C), respectively. Surface Burning Characteristics for flame spread and smoke developed values shall be 20 and 150, maximum, respectively.

2.2.03 Unfaced Flexible Glass Fiber Board Insulation. Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C553, Class B-4; with nominal density of 1.5 lbs per cu ft (24.0 kg per m^3) and r-value of 4.13 at 75 degrees F (23.9 degrees C), and maximum flame spread and smoke developed values of 25 and 50, respectively; passing ASTM E136 for testing of combustion characteristics.

2.2.04 Foil-Faced Flexible Glass Fiber Board Insulation. Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C553, Class B-4; with nominal density of 1.5 lbs per cu ft (24.0 kg per m^3) and r-value of 4.13 at 75 degrees F (23.9 degrees C); passing ASTM E136 for testing of combustion characteristics of unfaced board; foil-scrim-kraft vapor-retarder facing on one side with maximum flame spread and smoke developed values of 25 and 50, respectively.

2.2.05 Unfaced Glass Fiber Board Insulation. Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C612 and be Medium Density Semi-Rigid Board, Class 1 and 2, with nominal density of 3.0 lbs per cu ft (48.1 kg per m^3), and an r-value of 4.3 at 75 degrees F (23.9 degrees C). Combustion Characteristics shall pass ASTM E136 test.

2.2.06 Foil-Faced Glass Fiber Board Insulation. Thermal insulation produced by combining glass fibers with thermosetting resin binders to comply with ASTM C612 foil-scrim-kraft vapor-retarder facing on one side with maximum flame spread and smoke developed values of 25 and 50, respectively and be Medium Density Semi-Rigid Board; Class 1 and 2, with a nominal density of 3.0 lbs per cu ft (48.1 kg per m^3), and an r-value of 4.3 at 75 degrees F (23.9 degrees C). Combustion Characteristics shall be as for unfaced board and passing ASTM E136 test.

2.2.07 Unfaced Mineral Fiber Blanket/Batt Insulation. Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C665 for Type I (blankets without membrane facing): Mineral Fiber Type shall be manufactured fibers from glass or slag. Combustion Characteristics shall pass ASTM E136 test. Surface Burning Characteristics for flame spread and smoke developed values shall be 25 and 50 maximum, respectively.

2.2.08 Faced Mineral Fiber Blanket/Batt Insulation. Thermal insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C665 for Type III, Class A (blankets with reflective vapor-retarder membrane facing with flame spread of 25 or less); foil-scrim-kraft vapor-retarder membrane on one face, respectively. Mineral Fiber Type shall be fibers manufactured from glass or slag.

Combustion Characteristics shall be for unfaced blanket/batt and passing ASTM E136 test.

Surface Burning Characteristics shall have maximum flame spread and smoke developed values of 25 and 50, respectively.

2.2.09 Loose Glass Fiber Insulation. Glass fibers processed to comply with ASTM C764 for Type 2 (poured applications); passing ASTM E136 for combustion characteristics; maximum flame spread and smoke developed values of 5 and 5, respectively and for use as fire stopping.

2.2.10 Foamed in Place Insulation. Core-Fill 500 Foam Insulation as manufactured by Tailored Chemical Products, Hickory, NC, or approved equal. Core-Fill 500 is a nitrogen-based amino plast plastic foam insulation.

2.3 AUXILIARY INSULATING MATERIALS.

2.3.01 Polyethylene Vapor Retarder. Polyethylene film, not less than 10 mils (0.3 mm), with laboratory-tested vapor transmission rating of 0.2 perms, natural color.

2.3.02 Laminated Plastic/Paper Vapor Retarder. Kraft paper sheets laminated together with asphalt and glass fiber reinforcing, and with laminated black-colored polyethylene protection films both sides; laboratory-tested vapor transmission rating of 0.15 perms.

2.3.03 Metal Foil/Paper Vapor Retarder. 0.3-mil (0.008 mm) reflective aluminum foil laminated with scrim reinforcing to plastic-coated Kraft paper; laboratory-tested vapor transmission rating of 0.03 perms.

2.3.04 Vapor retarder tape: pressure-sensitive tape of type recommended by manufacturer, having fire hazard classification identical to that specified for insulation vapor retarder.

2.3.05 Adhesive for Bonding Insulation. Type recommended by insulation manufacturer, and complying with requirements for fire performance characteristics.

2.3.06 Mechanical Anchors. Type and size indicated or, if not indicated as recommended by insulation manufacturer for type of application and condition of substrate.

2.3.07 Mastic Sealer. Type recommended by insulation manufacturer for bonding edge joints between units and filling voids in work.

2.3.08 Crack Sealer for Board Insulation. Provide polymeric insulating foam in aerosol dispenser designed for filling voids in board insulation.

Product: Subject to compliance with requirements, provide "Polycel 100" by Construction Products Div., W.R. Grace & Co.

2.3.09 Protection Board. Premolded, semi-rigid asphalt/fiber composition board, 1/4" thick, formed under heat and pressure, standard sizes.

2.4 EXTERIOR FINISHED INSULATION SYSTEM. The System refers to an exterior assembly composed of an inner layer of thermal insulation board and an outer layer forming the protective finish coating. Designations for the class and type exterior insulation and finish system specified in this section are based on those developed by the Exterior Insulation Manufacturers Association (EIMA). Refer to the Drawings for the specific classes and types to be installed.

2.4.01 Compatibility. Provide board insulation, reinforcing fabric, base and finish coat materials, mechanical anchors and accessories which are compatible with one another and approved for use by system manufacturer.

Provide color and texture for protective coating to comply with the following requirements: Provide selection made by Owner from manufacturer’s full range of standard colors and textures available for type of finish coat indicated.

2.4.02 Expanded Polystyrene Board Insulation. Rigid, cellular thermal insulation with closed cells and integral high density skin, formed by the expansion of polystyrene base resin to comply with ASTM C578 for Type IV; with 2 lbs cu ft (32.0 kg per m^3) minimum density and 5 year aged r-value of 5.4 and 5 at 40 and 75 degrees F (4.4 and 23.9 degrees C); in manufacturer’s standard lengths and widths; thickness as indicated.

2.4.03 Reinforcing Fabrics. Balanced, alkali-resistant open weave glass fiber fabric treated for compatibility with other system materials, made from continuous multi-end strands with tensile strength of not less than 120 lbs (54.4 kg) and 140 lbs (63.5

kg) in warp and fill directions, respectively, per ASTM D1682 and complying with ASTM D578.

2.4.04 Bonding Agent for Reinforcing Fabric. System manufacturer's standard, factory-mixed copolymer emulsion for bonding reinforcing fabric to board insulation, where required by system manufacturer.

2.4.05 Base Coat Materials. Systems manufacturer's standard mixture complying with the following requirements for material composition and method of combining materials:

Job-mixed formulation of Portland cement complying with ASTM C150, Type I, natural color; clean, washed, silica sand complying with ASTM C897 and system manufacturer's requirements; alkali-resistant chopped glass fibers; and system manufacturer's standard polymer emulsion admixture for base coat use.

Factory-mixed formulation of Portland cement complying with ASTM C15, Type I, natural color; hydrated lime complying with ASTM C206, Type S; natural sand aggregate complying with ASTM C897 alkaline-resistant chopped glass fibers; and system manufacturer's standard dry binders and other admixtures.

Either job-mixed or factory-mixed formulations indicated above are acceptable.

Control Joints shall be prefabricated, one-piece type manufactured with expanded metal flanges, formed to provide double keying action with protective coating, and bellows portion extending only to face of insulation; with removable tape plaster face and joint opening width of 1/4 inch (6.4 mm).

Products, subject to compliance with requirements, similar to "Insuljoint I SV" by Metal Products Div., Keene Corp.

Expansion Joints shall be prefabricated, one-piece type manufactured with expanded metal flanges, formed to provide double keying action with protective coating, and bellows portion extending behind finish coat into gap between insulation boards; with removable tape on plaster face and joint opening width of 1/4 inch (6.4 mm).

Products, subject to compliance with requirements, similar to "Insuljoint I DV" by Metal Products Div., Keene Corp.

Corner Bead shall be prefabricated small-nosed corner bead with expanded metal flanges extending minimum of 2 7/8 (7.3 cm) from corner.

Casing Bead shall be prefabricated one-piece type for attachment to surface of insulation or behind insulation, of depth required to suit thickness of coating, and where attached behind insulating, thickness of insulation as well.

2.4.06 Polymer-Based Portland Cement Finish Coat Materials. System manufacturer's standard moisture complying with the following requirements for material composition and method of combining materials:

Job-mixed formulation of Portland cement complying ASTM C150, Type I, natural color or white; clean, washed, bagged silica sand complying with ASTM C897 and system manufacturer's requirements; color-fast mineral pigments; and system manufacturer's standard polymer emulsion admixture for finish coat use.

Factory-mixed formulation of Portland cement complying with ASTM C150, Type I, natural color; hrydated lime complying with ASTM C206, Type S; natural sand aggregate complying with ASTM C897, alkali-resistant chopped glass fibers; and system manufacturer's standard dry polymer binders and other admixtures.

Either job-mixed or factory-mixed formulation indicated above.

2.4.07 Top Coat for Polymer-Based Portland Cement Finish Coat. System manufacturer's factory-mixed pigmented polymer-based formulation. Top coat to resist mildew and dirt-pickup through integral polymer or silicone formulation.

2.4.08 Water. Clean and potable.

2.4.09 Mechanical Fasteners. System manufacturer's standard corrosion-resistant fastener assemblies, complete with system manufacturer's standard washer attachments, selected for properties of pull-out, tensile, and shear strength required to resist design loads of application indicated, capable of pulling fastener head below surface of insulation board.

2.4.10 Trim Accessories. Material as indicated below and type as designated or required to suit conditions indicated and comply with system manufacturer's requirements; manufactured from zinc alloy; coordinate depth of accessories with thickness of base and finish coats required.

PART 3 - EXECUTION

3.1 INSPECTION. Installer shall examine substrates and conditions under which insulation work is to be performed. A satisfactory substrate is one that complies with requirements of the section in which substrate and related work is specified. Report in writing listing conditions detrimental to performance of work in this section. Commencing installation constitutes acceptance.

3.2 PREPARATION. Clean substrates to manufacturer's requirements of substances harmful to insulations or vapor retarders, including removal of projections which might puncture vapor retarders.

Protect contiguous work from moisture deterioration and soiling resulting from application of systems. Provide temporary covering and other protection needed to prevent spattering of exterior finish coatings on other work.

Protect system, substrates and wall construction behind them from inclement weather during installation. Prevent infiltration of moisture behind system and deterioration of substrates.

3.3 INSTALLATION. Comply with manufacturer instructions for particular conditions of installation in each case. If printed instructions are not available or do not apply to project conditions, consult manufacturer technical representative for specific recommendations before proceeding with work.

Extend insulation full thickness as shown over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation. Remove projections which interfere with placement.

Apply a single layer of insulation of required thickness, unless otherwise shown or required to make up total thickness.

3.3.01 Vapor Retarders. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those which have been stuffed with loose fiber-type insulation.

Seal joints in vapor retarders by lapping not less than 2 inches (5.1 cm). Fasten vapor retarders at top, end and bottom edges, at perimeter of wall openings and at lap joints; space fasteners 16 inch (40.6 cm) o.c.

Seal overlapping joints in vapor retarders with adhesives or tape per vapor retarder manufacturer's printed directions. Seal butt joints and fastener penetrations with tape of type recommended by vapor retarder manufacturer. Locate all joints over framing members or other solid substrates. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by vapor retarder manufacturer.

Seal joints caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with cloth or aluminized tape of type recommended by vapor retarder manufacturer to create an air-tight seal between penetrating objects and vapor retarder.

Repair all tears and punctures in vapor retarders immediately before concealment by other work. Cover with tape or another layer of vapor retarder.

3.3.02 Perimeter and Under-Slab Insulation. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Use type of adhesive recommended by manufacturer of insulation.

Protect insulation on vertical surfaces (from damage during back-filling) by application of protection board. Set in adhesive in accordance with recommendations of manufacturer of insulation.

Place horizontal perimeter insulation on an appropriate vapor barrier for concrete work and level to finish flush with underside of floor slab.

Protect top surface of horizontal insulation (from damage during concrete work) by application of protection board.

3.3.03 Cavity Wall and Masonry Cell Insulation. On units of plastic insulation, install small pads of adhesive spaced approximately 1 feet - 0 inch (30.5 cm) o.c. both ways on inside face, as recommended by manufacturer. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose.

Foamed in place insulation to be installed when wall sections have been completed and sealed or closed. The foam insulation will be pumped through a 5/8 inch (1.6 cm) hole bored into the mortar joints around the entire wall area approximately 5 feet (1.52 m) from the floor level at each cell cavity. Repeat this method at an approximate height of 10 feet (3.05 m) until completion of the wall area. Foam to be installed from an open top in maximum heights of 10 feet to 12 feet (30.5 to 3.66 m) as wall sections are built.

3.3.04 Blanket Insulation. Install insulation blankets between framing members in as long lengths and width as practicable, with ends and side butted together and against building or construction, and with vapor barrier facing winter heated spaces. Cut insulation as required to fit building construction with no gaps or voids.

Secure insulation blankets to framing members with fastener as recommended by insulation manufacturer. Provide galvanized metal furring or metal bands or wire lacing as required to hold insulation blankets in place without sagging.

3.3.05 General Building Insulation. Apply insulation units to substrate by method indicated, complying with manufacturer's recommendations. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

Seal joints between closed-cell (non-breathing) insulation units by applying mastic or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with mastic or sealant.

Set vapor retarder faced units with vapor retarder to warm side of construction, except as otherwise indicated. Do not obstruct ventilation spaces, except for fire stopping.

Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure air-tight installation.

Set reflective foil-faced units accurately with air space in front of foil as shown. Provide not less than 0.75 inch (1.9 cm) air space where possible.

Place loose glass fiber insulation into spaces and onto surfaces as shown, either by pouring or by machine-blowing. Level horizontal applications to uniform thickness as indicated, lightly settled to uniform density, but not excessively compacted.

Stuff loose glass fiber insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40% of normal maximum volume (to a density of approximately 2.5 lbs per cu. ft. (40.0 kg/m^3)).

3.3.06 Protection. Protect installed insulation and vapor retarders from harmful weather exposures and from possible physical abuse, where possible by non-delayed installation of concealing work or, where that is not possible, by temporary covering or enclosure. Promptly remove protective coatings resulting from finish system installation from window and door grooves, and other surfaces not indicated to receive protective coating.

End of Section

SECTION 07410

SIDING/WALL PANEL SYSTEM

PART 1 – GENERAL

1.1 SCOPE. This section covers miscellaneous metal siding and insulated metal wall. Siding system is for walls, and soffits, with insulation, liners, related flashings and accessory components. Provide building paper back-up over wood or gypsum sheathed walls.

1.2 GENERAL. Extent of each type of siding is indicated on the drawings and by provisions of this section.

1.2.01 Governing Standards.

AAMA (American Architectural Manufacturers Association) 809.2 – Non Drying Sealant.

ASCE (American Society of Civil Engineers) 7 – Minimum Design Loads for Building and Other Structures.

ASTM (American Society for Testing and Materials) A36/A36M – Specification for Carbon Structural Steel.

ASTM A123/A123M – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A153/A153M – Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

ASTM A606 – Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A666 – Specification for Annealed or Cold-Worked Austenitic

Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A755/A755M – Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Preprinted by the Coil-Coating Process for Exterior Exposed Building Products.

ASTM A792/A792M – Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

ASTM A924/A924M – Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

ASTM B117 – Practice for Operating Salt Spray (Fog) Apparatus.

ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM C236 – Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.

ASTM C509 – Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.

ASTM C665 – Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

ASTM D226 – Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM D714 – Method for Evaluating Degree of Blistering of Paints.

ASTM D822 – Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Exposure Apparatus.

ASTM D968 – Test Methods for Abrasion Resistance of Organic Coatings by the Falling Abrasive.

ASTM D1654 – Test Method for Evaluation of Pained or Coated Specimens Subjected to Corrosive Environments.

ASTM D2244 – Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

ASTM D2247 – Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.

ASTM D4214 – Test Method for Evaluating the Degree of Chalking of Exterior Paint Films.

ASTM E72 – Test Method of Conducting Strength Tests of Panels for Building Construction.

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

ASTM E330 – Test Methods for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

ASTM E331 – Test Methods for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.

DOD-P-21035A – Paint, High Zinc Dust Content, Galvanizing Repair.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. Company specializing in manufacturing products specified in this section with minimum 3 years documented experience.

Design metal siding under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of Michigan.

1.3.02 Contractor's Qualifications. Metal wall panels and siding shall be installed by the manufacturer or his authorized representative, using workmen skilled in the trade.

Installer shall have 3 years documented experience installing siding/wall panel systems.

1.3.03 Testing: Provide preformed panel systems which have been pretested and certified by manufacturer to provide specified resistance to air and water infiltration and structural deflection and failure when installed as indicated and when tested in accordance with AAMA Standard Test TM-1, "Specification for Method of Test for Metal Curtain Walls for Water Penetration Using Dynamic Pressure".

1.3.04 Insulated Metal Wall Performance Criteria and Tests. Structural Tests: Design shall be verified by structural tests for wind loads by the "Chamber Method" as outlined in ASTM E72 or as approved by the Engineer.

1.3.05 Tolerances. Thermal properties for insulated panels shall provide a "U" value not greater than 0.064 Btu/hr/sq ft/degree F (0.36 watts/sqm/degrees C) when corrected to a 15 mph (24.1 kmh) wind condition for 2 inch (5.1 cm) thick flat panels, when tested in accordance with ASTM C236.

Fatigue test shall show no evidence of metal/foam interface delamination when the wall panel is tested by simulating wind loads of 20 psf (0.96 kPa) (positive and negative loads), when applied for two million alternate cycles. Test shall have been conducted and verified by an independent testing laboratory.

No metal primer interface corrosion and/or delamination shall occur after 1,000 hours at 135 degrees F (57.2 degrees C) and 100 percent relative humidity. No delamination after 2 1/2 hours in a 2-psi (13.8 kPa) 212 autoclave when conducted and verified by an independent testing laboratory.

There shall be no uncontrolled water leakage at 6.24 psf (0.3 kPa) air pressure differential when tested in accordance with ASTM E331. Wall assembly shall contain at least one principal horizontal joint.

Fire hazard: Insulating foam core and panel shall have the following fire hazard classification when tested in accordance with ASTM E84:

	Exterior Surface	Interior Surface	2 inch (5.1 cm) Core Material
Flame spread	10	20	25
Smoke	10	65-110	150

Insurance Ratings: Panels shall be rated and carry one or more of the listings: FM Class 1 rating, UL Guide NYVQ (corner tests), and/or ICBO Research Report PFC-330

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit small-scale layouts of panels on walls and large-scale details of edge conditions, joints, corners, custom profiles, supports, anchorages, trim flashings, closures, and special details. Distinguish between factory and field assembly work.

1.4.02 Certifications. Submit statement of compliance on manufacturer's letterhead stating that materials, fabrication and installation comply with requirements indicated and specified.

1.4.03 Samples. Submit representative samples of metal panels in inspection showing interior and exterior facing sheets, insulating core, tongue and grooved edge joints, continuous gasketing or sealing and finish. Submit 2 samples 12 inch (30.5 cm) sq of each exposed finish material. Submit Samples of accessory items.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver metal panels and siding to the job site in properly braced and covered containers to protect panels from bending kinking, warping, damage to the finish and protection from the elements.

Store metal panels and siding at the job site until installed in place off the ground, in a slightly titled lengthwise position, supported full length, in a dry ventilated area or under weatherproof cover. Protect panels from accelerated weathering by removing or venting sheet plastic wrap.

1.6 WARRANTY. Contractor shall provide a 5 year warranty for metal panels and siding in addition to any other warranties offered by manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall at a design pressure of 20 lbs per sq ft (0.96 kPa) or higher as required by AAMA specifications for the particular geographic area involved. Maximum allowable deflection of panel span when tested for single, double, or triple spurs indicated.

Accommodate movement within system without damage to components or deterioration of seals, movement within system; movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; deflection of structural support framing.

Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.

2.2 ACCEPTABLE MANUFACTURERS. Subject to compliance with requirements, provide preformed siding products by Atas International, Inc., Centria, Englert Inc., McElroy Metal, Inc., Peterson Aluminum Corp., or approved equal.

2.3 MATERIALS.

2.3.01 Steel for Painting/Coating. Hot-dip zinc coated steel sheet, ASTM A653, Grade A except where higher strength required for performance, G90 zinc coating, surface treated for maximum coating performance.

2.3.02 Metal Finishes. Apply coatings either before or after forming and fabricating panels, as required by coating process and as required for maximum coating performance capability. Protect coating promptly after application and cure, by application of strippable film or removable adhesive cover, and retain until installation has been completed. Provide colors or color matches as indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors.

Fluoropolymer coating shall be full-strength 70 percent "Kynar 500" coating baked-on for 15 minutes at 450 degrees F (232.2 degrees C), in a dry film thickness of 1.0 mil (0.03 mm), 30 percent reflective gloss (ASTM D 523), over min. 0.2 mil (0.005 mm) baked-on modified epoxy primer.

Provide durable coating which has been field tested under normal range of weathering conditions for minimum of 20 years without significant peel, blister, flake, chip, crack or check in finish, and without chalking in excess of 8 (ASTM D4214), and without fading in excess of 5 NBS units. Abrasion resistance shall be per ASTM D968 following said test and have a minimum coefficient abrasion of SS.

2.3.03 Accessories. Except as indicated as work of another specification section, provide components required for a complete curved siding system, including trim, copings, sills, corner units, ridge closures, clips, seam covers, battens, flashings, closure strips and similar items. Match materials/finishes of curved preformed panels. Fasteners shall be manufacturer's standard non-corrosive types, with exterior heads gasketed.

2.3.04 Insulated Metal Wall Materials. Materials shall comply with the references and requirements specified.

Steel shall be steel sheet, structural quality, galvanized, ASTM A653, Coating Class as specified.

Bars & structural shapes, hot rolled shall comply with ASTM A36.

Insulation shall be urethane or isocyanurate foam listed by UL and having a Factory Mutual (FM) Class 1 rating. Density shall be 2.5 lbs cu ft (40.0 kg/m^3) minimum. Shear strength shall be at least 20 psi (137.9 kPa). Tensile strength shall be 30 psi (206.8 kPa) minimum. Compressive strength shall be 20 psi (137.9 kPa) minimum. Insulation shall have a 93 percent closed cell structure. Insulation shall withstand heat-aging at 158 degrees F (70 degrees C) and 100 percent relative humidity for a period of 14 days with a volume increase not greater than 6.6 percent and withstand heat-aging at 200 degrees F (93.3 degrees C) for a period of 14 days with a volume of 4.0 percent. Insulation shall withstand cold-aging at minus 10 degrees F (-23.3 degrees C) for a period of 14 days with loss in volume not greater than 0.3 percent.

Glass fiber insulation for filling voids in panel system, where foam fill has been removed to accommodate cutting, fitting and forming panels at corners, penetrations, and other locations shall comply with ASTM C665, Type I.

Joint Sealant shall be non-drying non-skinning, non-oxidizing polybutene type complying with AAMA 809.2.

Gasketing shall be continuous neoprene gaskets, if used for sealing tongued and grooved side joints: ASTM C509, Type II.

Clips shall be concealed clip angles for edge fastening of panels: minimum 12 gage (2.8 mm) galvanized steel.

Fasteners shall be self-tapping type, cadmium-plated carbon steel, designed to resist maximum negative pull-off loads and hold the panels mechanically to the structural building girts.

Expansion Shields shall be Fed. Spec. FF-S-325, machine bolt type, tubular type, or self-drilling tubular type.

Steel bolts, standard fasteners shall comply with ASTM A307.

Touch-up paint for field touch-up of galvanized steel sheet shall be ZRC Chemical Products Co. “Z.R.C.”, other zinc-rich paint complying with Mil. Spec. DOD-P-21035, or a type recommended by manufacturer. Such touch-up shall be of a minor nature, subject to inspection

2.4 MANUFACTURER AND FABRICATION. Fabricate and finish panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, and as required to fulfill indicated performance requirements which have been demonstrated by factory testing. Comply with indicated profiles and dimensional requirements, and with structural requirements. Panel profile to be Super-Rib Wall Panel by Centria.

Thickness of metal gages are required to be noted for structural performances, but not less than manufacturer's recommended minimums for profiles and applications indicated, and not less than 8 gage (4.3 mm) for exterior panels.

Fabricate panels and other components of wall system for installed-as-indicated performances of 20 lbs per sq ft (0.96 kPa) inward and 15 lbs per sq ft (0.72 kPa) outward wall loading.

Apply bituminous coating or other permanent separation materials on concealed panel surfaces where panels would otherwise be in direct contact with substrate materials which are non-compatible or could result in corrosion or deterioration of either material or finishes.

Fabricate panel joints with captive gaskets or separator strips, which provide a tight seal and prevent metal-to-metal contact in a manner which will minimize noise from movements within panel system.

2.4.01 Metal Wall Panels. Metal panels shall be 24 inches (61.0 cm) wide and no more than 2 inches (5.1 cm) thick, factory-formed, consisting of exterior and interior face sheets, insulating foamed bonding core and tongued and grooved side joints, continuously sealed or gasketed. Panels shall be in continuous lengths that will best accommodate building elevations required, with minimal or no horizontal joints, and meeting the performance criteria specified.

Exterior face sheet shall be G90 galvanized coated steel in metal thickness required to meet performance criteria specified. Face sheet surface shall be flat with fine vertical ripple or stucco embossed pattern to minimize oil-canning.

Finish for exterior and interior face sheet shall be fluorocarbon. Color shall be as selected by the Engineer.

Accessories such as exposed trim and flashing, other than extruded trim, on exterior shall be of same material and given same finish as exterior facing sheet. Ferrous metal fastenings shall be stainless steel.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that in-place construction on which this Work is dependent is free of defects which may influence satisfactory completion and performance of the Work. Beginning of installation means acceptance of in-place construction.

3.2 PREPARATION. Protect the Work and adjacent construction against damage.

3.3 INSTALLATION. Comply with panel fabricator’s and material manufacturer’s’ instructions and recommendations for installation, as applicable to project conditions and supporting substrates. Anchor panels and other components of the work securely in place, with provisions for thermal/structural movement. Entire installation shall be weather tight and in compliance with performance requirements.

3.3.01 Erection. Erect panels with vertical joints plumb and truly vertical, and with fastenings to structure concealed in joints.
Field-cut panels at corners and other required locations shall be cut maximum practical size so that the ends butt at the corner seal cut edges before installation. Surfaces of cut panels shall not show any buckling or other surface damage beyond edge of corner trim. Cut panels for insertion of window in panels where required. Provide accessories required for installation of panels to steel framing members.

When erecting panels, take care that continuous gaskets or sealant strips are properly in place. Replace any sections which are loose or have fallen out. Maximum variation in plane of adjacent panels shall be 1/16 inch (1.6mm).

Provide flashing, trim and other accessories for a complete and weather tight installation, including head, jamb, sill flashing at openings as well as base flashing. Also provide corner trim, interior and exterior.

3.3.02 Manufacturers Field Services. Where possible, prior to fabrication of prefabricated panels, manufacturer shall take field measurements of structure or substrates to receive panel system. Allow for trimming panel units where final dimensions cannot be established prior to fabrication.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. Maximum offset from true alignment between adjacent members butting or in line shall be 1/16 inch (1.6 mm). Maximum variation from plane or location shall be 1/4 inch (6.4 mm) or as indicated on the drawings.

3.4.02 Inspection. At completion of erection inspect surfaces with the Engineer. Replace panels and other components of the work which have been damaged or have deteriorated beyond successful repair by means of finish touch-up or similar minor repair procedures.

3.4.03 Cleaning. Remove temporary protective coverings and strippable films (if any) as each panel is installed. Upon completion of panel installation, clean finished surfaces as recommended by panel manufacturer, and maintain in a clean condition during construction.

End of Section

SECTION 07500

FLASHING AND TRIM

PART 1 – GENERAL

1.1 SCOPE. This section includes metal counter flashing and base flashing, metal wall flashing and expansion joints, metal scuppers, exposed metal trim, fascia and coping units, cap flashings and miscellaneous sheet metal accessories. It also addresses elastic roof/wall expansion joint systems, laminated and composition flashing, and coatings and slip sheets to isolate sheet metal from dissimilar material.

Roofing accessories which are installed integral with roofing work are specified in Master Specification Section 07200, Roofing and Accessories.

1.2 REFERENCES.

1.2.01 Governing Standards.

AAMA (American Architectural Manufacturers Association) 611 - Standards for Anodized Architectural Aluminum.

AAMA 808.3 - Exterior Perimeter Sealing Compound.

ASTM (American Society for Testing and Materials) A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel-Steel Plate, Sheet, and Strip.

ASTM A480/A480M – Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

ASTM A606 – Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot Rolled and Cold Rolled, with Improved Atmospheric Resistance.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

ASTM A924/A924M – Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

ASTM B32 - Specification for Solder Metal.

ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B370 - Specification for Copper Sheet and Strip for Building Construction.

ASTM D226 - Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

ASTM D2178 – Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.

ASTM D4397 – Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

ASTM D4586 – Specification for Asphalt Roof Cement, Asbestos-Free.

AWS (American Welding Society) D1.3 – Structural Welding Code-Sheet Steel.

DOD-P 21035A – Paint, High Zinc Dust Content, Galvanizing Repair.

FFS (Federal Specification) 325 – Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry).

FS TT-C-494B – Coating Compound, Bituminous, Solvent Type, Acid Resistant.

SMACNA (Sheet Metal and Air Conditioning Contractors National Association) – Architectural Sheet Metal Manual.

1.3 QUALITY ASSURANCE.

1.3.01 Contractors Qualifications. A company familiar with installing products included in this section and which has completed at least 20 installations similar in scope to work included in this section.

1.3.02 Quality Standard. Fabricate and install sheet metal work in accordance with Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) "Architectural Sheet Metal Manual," unless specifically indicated otherwise.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit layout drawings of each item indicating dimensions, material, metal gauges and other pertinent construction and erection details.

Product Data: Submit manufacturer's technical information and installation instructions, in sufficient detail to demonstrate products comply with contract documents.

Samples: Submit two (2) 6 inch (15.2 cm) square samples of each type of metal and finish required.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver materials to the project site in their original unopened containers, or packages or bundles, bearing label clearly identifying manufacturer's name, brand name, and other pertinent information.

Store materials in dry and protected storage facilities until ready for use,

1.6 WARRANTY. Warrant sheet metal work, except items embedded in built-up roofing and forming an integral part of built-up roof system, for 2 years against defective materials, workmanship and leaks, except leaks caused by abuse, lightning, hurricane, tornado, hail storm, unusual climatic phenomena or failure of related work installed by other parties.

During the warranty period, restore defective work to the standard of the contract documents, including all materials, labor, refinishing and other costs incidental to the work. Within 24 hours after receipt of notice from the Engineer, inspect the work and immediately repair leaks. Restore work found to be defective as defined in the contract documents within 10 days after receipt of notice from the Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide products of Cheney Flashing Co., Keystone Flashing Co., GAF Materials Corp., Peterson Aluminum Corp. or approved equal.

2.2 MATERIALS.

2. 2.01 Galvanized Steel Sheet. ASTM A653, commercial quality, G90 hot-dip galvanized.

2.2.02 Pre-finished Galvanized Steel Sheet. Coil coated, commercial quality steel sheet, ASTM A924 Grade A or ASTM A653, G90 hot-dip galvanized shall be 70 percent "Kynar 500" or "Hylar 5000" resin finish over epoxy primer; minimum system thickness 1.0 mil (0.03 mm). Provide manufacturer’s standard prime coat on underside. Color shall be selected by Owner, after contract award, from manufacturer's standard color selection.

Provide strippable plastic protective film or, pre-finished surface.

2.2.03 Stainless Steel Sheet. ASTM A167, Type 302 or 304 sheets or strips, dead soft fully annealed, 2D or 2B finish per ASTM A480. Fastenings shall be stainless steel nails or screws. Solder shall be ASTM B32, alloy grade 60A bar form (40 percent pig lead and 60 percent pure block tin). Flux shall be acid type for pretinning and activated- rosin-alcohol type for soldering, or non-corrosive type such as Gregory Fabricators "Gregory 200."

2.2.04 Pre-finished Aluminum Sheet. ASTM B209, manufacturer's standard alloy, and temper for indicated applications. Minimum thickness shall be 20 gage (1.0 mm), unless indicated otherwise. Finish shall be 70 percent "Kynar 500" or "Hylar 5000" resin finish over epoxy primer: minimum system thickness 1.0 mil (0.03 mm). Provide manufacturer's standard prime cost on underside. Color shall be selected by Owner after contract award, from manufacturer's standard color selection, Provide strippable plastic protective film on pre-finished surface.

2.2.05 Laminated Sheet Flashing. Laminate 1 layer of asphalt Kraft paper or asphalt impregnated fabric to each face of a 5 ounce copper sheet. Provided they comply with requirements of the Contract documents, provide "AFCO Cop-A-Bond Duplex" by AFCO Products, Inc. and "Cop-R-Tex Duplex" by York Manufacturing, Inc. or approved equal.

2.2.06 Special (Thru-Wall) Flashings. Interlocking flashing: 0.015 inch (0.4 mm) stainless steel sheet, deformed to provide a keyed mortar bond where indicated on the Drawings per SMACNA, Inc. Architectural Sheet Metal Manual, Plate 54, Fig. C.

2.2.07 Reglet. Reglet for flashing in concrete wall: Cheney Flashing Company Type A SnapLock", 1/4 inch (6.4 mm) deep, formed of 0.015 inch (0.4 mm) thick, dead soft stainless steel complete with prepunched nail holes at 12 inches (30.5 cm) on center and required matching nails or screws.

2.2.08 Self-Adhesive Sheet Eaves Ice and Snow Underlayment. Rubberized asphalt sheets with polyethylene film facing packaged in rolls with disposable release paper. Minimum thickness shall be 34 mils (0.9 mm) nominal. Provided they comply with requirements of the contract documents, "Polyguard Dock Guard" Polyguard Products, Inc., "Royston Ice and Water Gard" membrane; Royston Laboratories, Division/Chase Corporation, and "Ice and Water Shield", W. R. Grace & Company or approved equal.

2.2.09 Fasteners. Corrosion-resistant metal of same material as the material being fastened, or other material recommended by sheet metal manufacturer. Match finish and color of exposed fastener heads to finish and color of sheet material being fastened.

Concealed Fasteners shall be of the same metal as item fastened or other noncorrosive metal as recommended by manufacturer,

2.2.10 Mastic Sealant. Polyisobutylene; non-hardening, nonskinnning, nondrying, nonmigrating sealant. Mastic shall be asphalt base mixture complying with ASTM D4586, Type 1.

2.2.11 Foam Rubber Seal. Manufacturer's standard foam.

2.2.12 Metal Joint Sealant. A non-drying, non-skinning, non-oxidizing, butyl sealant complying with AAMA Specification 808.3, such as Protective Treatments, Inc. "PTI 707." Use noncuring type for concealed joints. Use nonsag electromeric type for exposed joints.

2.2.13 Sealant (Aluminum Riveted Joints). Alcoa "GutterSeal."

2.2.14 Adhesives. Types recommended by manufacturer for substrate and project conditions, and formulated to withstand min. 60 psf (2.9 kPa) uplift force. Use two-component noncorrosive epoxy adhesive recommended by metal manufacturer for sealing of nonmoving joints,

2.2.15 Expansion Shields. Fed. Spec, FF-S-325, machine bolt type, tubular type, or self-drilling tubular type.

2.2.16. Bituminous Coating. Heavy bodied, sulfur-free, asphalt-based paint; FS TT-C-494.

2.3 MANUFACTURER AND FABRICATION. Form sheet metal to match profiles indicated, substantially free from oil-canning, fish-mouths, and other defects. Provide fascia and copings equal to Snap-Lok Coping Systems as manufactured by MM Systems Company, which are designed and fabricated to fit applications indicated and to perform optimally with respect to weather resistance, water tightness, durability, strength, and uniform appearance.

Comply with SMACNA "Architectural Sheet Metal Manual" for applications indicated.

Provide for thermal expansion of exposed sheet metal work exceeding 15 feet (4.6 m) running length.

2.3.01 Flashing and Trim. Provide movement joints at maximum spacing of 10 feet (3.05 m); no joints allowed within 2 feet (61.0 cm) of a corner or intersection. Fabricate fascia and copings to allow not only for movement of metal components in relationship to one another but also to adjoining dissimilar materials, including flashing and roofing membrane materials, in a manner which is sufficient to prevent water leakage, deformation or damage.

Conceal fasteners and expansion provisions wherever possible.

Exposed fasteners are not allowed on faces of sheet metal exposed to public view. Form a 1/2 inch (1.3 cm) hem on underside of exposed edges.

Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.

Gage: As recommended by SMACNA or metal manufacturer for application, but in no case less than gage of metal being secured.

2.3.02 Metal Fabrications. As a minimum, fabricate flashings using materials in the thickness listed for each flashing application, or as indicated on the drawings.

2.3.03 Two Piece, Type II Flashing. The receiver portion shall have outer edge formed into a double fold turned down 1 inch (2.5 cm), unless otherwise indicated, and shall be fabricated as follows:

The upper portion of the receiver shall extend up at an angle and then vertically 3 inches (7.6 cm). The uppermost portion shall be formed outward 1/2 inch (1.3 cm) at 45 degrees to receive sealant.

2.3.04 Pressure Bar. Pressure bar shall be 3/16 inch x 1 inch (4.8 mm x 2.5 cm) stainless steel bars.

2.3.05 Seaming. Provide seams which are appropriate for the various conditions encountered in the work; locked, lapped or cleated, and soldered or sealed watertight with sealant, as indicated or required. Make ample provisions for expansion and contraction.

Standing seams finish shall be not less than 1 inch (2.5 cm) high. Flat seams finish shall not be less than 3/4 inch (1.9 cm) wide. Soldered lap seams finish shall not be less than 1 inch (2.5 cm) wide. Unsoldered plain lap seams lap shall not be less than 3 inches (7.6 cm). All seams on sloped surfaces shall be in direction of waterflow.

2.3.06 Soldering Stainless Steel. Clean, roughen and pretin edges of sheet metal to be soldered. Remove all flux residue from acid type flux by scrubbing, neutralizing with ammonia or washing soda, and rinsing with water. After pretinning and assembling of parts, solder and thoroughly clean the surfaces as recommended by manufacturer of stainless steel sheet.

Clean stainless steel surfaces, using detergent for loose dirt and commercial cleaner containing phosphoric or oxalic acid for stubborn deposits.

2.3.07 Cap Flashing. Fabricate cap flashing of 0.018 inch (0.5 mm) thick stainless steel sheet. Provide 2 piece metal cap flashing, consisting of an upper receiver portion and a lower portion extending over the composition flashing, unless otherwise specified.

For 2 piece cap flashings, fabricate the receiver portion with outer edge formed into a double fold turned down 1 inch (2.5 cm), unless otherwise indicated, and as follows:

At new masonry walls, extend the receiver portion into the wall as indicated, terminated with 1/4 inch (6.4 mm) upstand edge, unless indicated to be higher.

At walls faced with metal siding or preformed metal panels, extend the receiver portion into the wall as indicated and terminate with edge folded over support.

At concrete and existing masonry walls, extend the receiver portion into saw cut or form the receiver portion to retain sealant as indicated, using a 3/16 by 1 inch (4.8 mm x 2.5 cm) stainless steel clamping bar.

At parapet, extend the receiver portion over wood blocking as indicated.

Form the upper edge of the lower portion of metal cap flashing to engage in the double fold of receiver portion, bent to provide spring action against the base flashing, fold the lower edge folded back 1/2 inch (1.3 cm) and lap composition base flashing not less than 4 inches (10.2 cm).

Lap ends of each length of both portions of metal cap flashing not less than 3 inches (7.6 cm). Weld or solder corner joints. Return ends at roof edge into reglet or wall,

Provide 1 piece cap flashing at roof curbs, with top edge formed to retain metal joint sealant and bottom edge folded 1/2 inch (1.3 cm) to provide drip.

2 3.08 Coping. Fabricate coping and accessories of stainless steel sheets of the correct thicknesses. For coping, fabricate to thickness of 0.024 inches (0.6 mm). For splice plates, fabricate to a thickness of 0.015 inches (0.4 mm). For cleat, use 0.036 inches (0.9 mm) thickness.

Shop fabricate coping sections in 8 ft (2.4 m) lengths and of 1 piece material of sufficient width. Provide sections in 1 piece assemblies around internal and external corners, with vertical portion bent and horizontal portion mitered and welded. Form edge on roof side into a double fold turned down 1 inch (2.5 cm). Form vertical face with lower edge folded under 1/2 inch (1.3 cm) and bent to suit cleat.

Provide 12 inch (30.5 cm) wide plates for joints, profiled to suit entire coping, including the bent portion of the cleat.

Provide continuous cleat, 1 3/4 inches (4.4 cm) wide unless otherwise indicated, with 1 inch (2.5 cm) vertical leg and 3/4 inch (1.9 cm) leg bent out at 30 degrees, in sections of maximum practical length.

2.3.09 Roof Penetration Flashing. Fabricate flashing sections of 0.018 inch (0.5 mm) thick stainless steel sheet, with 1/8 by 1 inch (3.2 mm x 2.5 cm) stainless steel clamping bar or draw band (hose clamp type tightened with screw). Fabricate flashing in 2 sections as indicated, with lower section of height indicated and a minimum 4 inch (10.2 cm) wide flange onto roof.

Provide flashing assembly for all roof penetrations, such as vent stacks, piping, equipment supports. Deliver to site in ample time to avoid delays in other work. Installation is specified as part of the built-up bituminous roofing work.

2.3.10 Guffers, Conductors, and Splash Pans. For Type I Gutters, Stainless Steel: Fabricate gutters, apron pieces, and cleats where required to be aluminum of 0.032 inch (0.8 mm) thick aluminum, sheets in sections 10 feet (3.05 m) long. Stiffening bar shall be extruded aluminum.

Fabricate gutters, apron pieces and cleats where required to be stainless steel of .018 inch (0.5 mm) thick, stretcher leveled stainless steel sheet in sections 10 feet (3.05 m) long. Stiffening bar shall be stainless steel.

Form gutters to shape required.

Join adjacent sections by 1 inch (2.5 cm) side laps, riveted at 2 inch (5.1 cm) spacing and soldered where stainless steel is used, and riveted and sealed watertight with the specified sealant if aluminum is used.

Provide transverse gutter spacers at 36 inch (91.4 cm) intervals, 1 1/2 inches (3.8 cm) wide and formed of same material as gutter into a 3/4 inch (1.9 cm) deep channel with 3/4 inch (1.9 cm) end flanges. Attach spacers to front and rear top edges of gutter using rivets, Locate spacers midway between brackets.

Provide gutter expansion joints as required at a maximum of 40 feet (12.2 m) on center or as required.

Provide end pieces at gutter ends.

Apron Pieces: Form gutter apron piece in 8 foot (2.4 m) lengths, with 1 edge extending onto roof not less than 4 inches (10.2 cm). The sheet metal shall extend down over the rear surface of the gutter to form an apron. The apron shall be crimped and lower edge bent to form a drip. Notch apron piece around spacers.

Provide Type I stainless steel gutter brackets to support stainless steel gutters where required of 1/8 x 1 1/2 inch (3.2 mm x 3.8 cm) stainless steel bar..

Provide brackets 6 inches (15.2 cm) from ends and at 36 inch (91.4 cm) intervals over length of gutter runs. Provide 2 holes in bracket for fastening to nailer.

Type I outlet tubes for connection to stainless steel conductors shall be formed of 0.018 inch (0.5 mm) thick stainless steel sheet with locked and soldered longitudinal seam, the upper end of tubes shall be flanged 1/2 inch (1.3 cm) and soldered to gutter inner surface. Tubes shall extend into conductors at least 3 inches (7.6 cm).

Type I Wire basket strainers at stainless steel gutters shall be formed from 0.114 inch (2.9 mm) diameter stainless steel wire. Provide strainers at outlet tubes, fitting snugly in tubes.

Fabricate Type I Conductors at stainless steel gutters of corrugated 0.018 inch (0.5 mm) thick stainless steel sheet. Conductors shall be constructed in 10 foot (3.05 m) lengths where possible. Telescope end joints 1 1/2 inches (3.8 cm) and lock longitudinal joints. Provide necessary elbows, offsets and the like as required to complete the installation. Conductors shall be 3 inches (7.6 cm) in diameter unless otherwise required.

Fabricate Type I Straps at stainless steel conductors of 0.018 inch (0.5 mm) thick stainless steel sheet. Fabricate straps 2 inches (5.1 cm) wide and of design to hold conductor clear of wall. Provide quantity adequate for installation at not over 48 inch (1.2 m) intervals.

Splash Pans: Fabricate splash pans of 0.024 inch (0.6 mm) thick stainless steel sheet. Splash pans shall be fabricated to the required dimensions. Provide baffles and horizontal flanges as required. Rear end of pan shall extend over cant and have top edge formed to engage in receiver or cap flashing built into wall. Provide cap flashing for building

2.3.11 Thru Wall Flashings. Flashings under masonry coping: the interlocking type, profile as required with a double fold turned down 1 inch (2.5 cm). Provide for 3 inch (7.6 cm) lap joints.

Thru wall flashings other than the above: 0.010 to 0.015 inch (0.3 to 0.4 mm) stainless steel, profile as required, Provide four inch (10.2 cm) lap joints. Form ends of non continuous flashing over openings to provide a 1 inch (2.5 cm) high dam.

PART 3 – EXECUTION

3.1 INSPECTION. Examine substrates and conditions under which products of this section are to be installed and verify that work may properly commence. Do not proceed with the work until unsatisfactory conditions have been fully resolved Verity that nailers, blocking, and other attachment provisions for sheet metal work are properly located and securely fastened to resist effects of wind and thermal stresses.

3.2 PREPARATION. Protect this work and adjacent construction against damage during progress of work until completion. Take precautions to prevent damage to work from traffic or placement of heavy materials thereon.

Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal. Isolate dissimilar metals by means of a heavy bituminous coating, approved paint coating, adhered polyethylene sheet, or other means approved by the Engineer.

3.3 INSTALLATION. Surfaces to be flashed or covered with sheet metal shall be clean and free from defects. Clean foreign matter from surfaces. Drive projecting nails flush. Comply with sheet metal manufacturer's installation methods and recommendations in the SMACNA "Architectural Sheet Metal Manual." Coordinate with installation of roof deck and other substrates to receive work of this section, with vapor retarders, roof insulation, roofing membrane, flashing, and wall construction; as required to ensure that each element of the work performs properly, and that combined elements are waterproof and weather tight. Anchor products included in this section securely to structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

3.3.01 Isolation. Where metal surfaces of units are installed in contact with dissimilar metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation as recommended by manufacturer.

Secure flashings in place using concealed fasteners. Apply plastic cement compound between metal flashings and felt flashings. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles. Install snow guards up slope from eaves and valleys. Secure gutters and downspouts in place using concealed fasteners. Slope gutters minimum 1/4 inch per ft (2.1 cm per m). Set splash pans under down spouts.

3.3 02 Eaves Ice and Snow Underlayment. Install 1 layer of self adhesive underlayment starting at the roof edge and extending as indicated on the drawings, with minimum 4 inch (10.2 cm) side laps and 6 inch (15.2 cm) end laps.

3.3.03 Sealed Joints. Seal water joints watertight. Form minimum 1 inch (2.5 cm) hooked joints and embed flange into sealant or adhesive. Form metal to completely conceal sealant or adhesive. Use joint adhesive for nonmoving joints specified not to be soldered.

3.3.04 Moving Joints. When ambient temperature is moderate (40 to 70 degrees F (4.4 to 21.1 degrees C)) at time of installation, set joined members for 50 percent movement either way. Adjust setting position of joined members proportionally for temperatures above 70 degrees F (21.1 degrees C).

Do not install sealant at temperatures below 40 degrees F (4.4 degrees C). Clean surfaces to be soldered, removing oils and foreign matter.

3.3.05 Cap Flashing. Install metal cap flashing over composition base flashing which turns up onto vertical surfaces.

In new masonry work, set flashing in a bed of mortar both above and below the metal.

At concrete and existing masonry walls, wedge the receiver portion into a saw cut with coiled metal plugs compatible with the receiver or neoprene wedges, 12 to16 inches (30.5 to 40.6 cm) on center, unless otherwise indicated, or anchor clamping bar to wall with screws and expansion shields, as indicated.

At concrete walls in cavity construction, insert the receiver portion into the reglet.

Insert lower portion into receiver portion and fasten with screws at 12 inch (30.5 cm) spacing and of length required to join the metal but not project into substrate behind flashing.

At roof curbs, apply metal joint sealant and install 1 piece cap flashing as indicated.

Lap section ends a minimum of 3 inches (7.6 cm) and seal watertight with mastic.

3.4 PROTECTION. Protect sheet metal work as recommended by the installer so that completed work will be clean, secured and without damage at substantial completion.

3.5 CLEANING. Remove protective film from pre-finished sheet metal immediately after installation. Clean exposed metal surfaces in accordance with manufacturer's instructions. Touch up damaged metal coatings. Remove from sheet metal surfaces any debris or substances which will inhibit uniform weathering.

Repair or replace work which is damaged or defaced, as directed by the Engineer. Refinish marred and abraded areas of pre-finished sheet using finish manufacturer's recommended methods and materials. Replace units which, in the opinion of the Engineer, cannot satisfactorily be refinished in place.

End of Section

SECTION 07600

CAULKING AND SEALANTS

PART 1 - GENERAL

1.1 SCOPE. This section covers caulking and sealing.

1.2 GENERAL.

1.2.01 Coordination. At least 2 weeks prior to installation of caulking or sealant work, arrange a meeting with the Engineer and a representative of the sealant manufacturer to review sealing procedures and products to be used. Give at least 2 weeks notice to concerned parties.

Furnish for review at the meeting, samples of sealant on production runs of substrate material, prepared as described below, as proof of adhesion of each sealant to each respective substrate. Furnish substrate samples prepared, cleaned, primed (if required) and sealant installed the same as for the sealant work. After the sealant manufacturer's recommended curing period, immerse the samples in tap water for at least 24 hours and present for review while immersed.

1.2.02 Governing Standards.

ASTM (American Society for Testing and Materials) C794 – Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.

ASTM C834 – Specification for Latex Sealants.

ASTM C919 – Practice for Use of Sealants in Acoustical Applications.

ASTM C920 – Specification for Elastomeric Joint Sealants.

ASTM C1021 – Practice for Laboratories Engaged in the Testing of Building Sealants.

ASTM C1087 – Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.

ASTM C1115 – Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.

ASTM C1193 – Guide for Use of Joint Sealants.

ASTM C1311 – Specification for Solvent Release Sealants.

ASTM D1056 – Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.

ASTM D1667 – Specification for Flexible Cellular Materials – Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).

ASTM D2628 – Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Caulking and sealing work shall be installed by a contractor that has specialized in the type of Work specified and indicated on the Drawings for at least the past 5 years. Submit evidence of successful experience on projects similar in size and scope to this Work.

1.3.02 Testing. Provide comprehensive test data for each type of caulk or sealant based on tests conducted by a qualified independent testing laboratory on current product formulations within a 24 month period preceding date of Contractor's submittal of test results to Engineer.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Caulk and sealant manufacturer's product descriptions with instructions, including limitations for storage, joint opening preparation, and installation of caulk, sealants and joint components. Indicate where primers will be used or submit printed statement from manufacturer that no primers are required for adequate adhesion.

Joint sealant backing and bond breaker manufacturer's product description with instructions, including limitations for storage, handling and installation.

Caulk and sealant manufacturer's standard color range for color selection, unless indicated otherwise.

1.4.02 Certifications. Submit statement written on applicable manufacturer's official letterhead and signed by the responsible representative, indicating that products proposed for use have been tested and conform to the requirements of the Contract Documents and the following:

The sealant meets applicable referenced specification requirements.

The sealant is compatible with specified sealant backing materials and does not adhere to specified bond breaker as determined by ASTM C1087.

The sealant is compatible with and has been tested for adequate adhesion to each respective substrate. Include identification of any primers required to obtain adequate adhesion.

Furnish manufacturer's statement dated no earlier than one year prior to submittal. Submit test reports, as partial fulfillment of these requirements, from the manufacturers or an independent laboratory. Testing shall comply with ASTM C1021. Include a list of tests made and their results. Test data more than two years old may be submitted provided manufacturer indicates in the statement of compliance that the tested sealants have not changed in formula or manufacture sufficient to produce different results.

Schedule sufficient time for the conducting of testing, certification of results and submission, to not cause a delay in the progress of the work.

1.4.03 Samples. Submit samples of each type and color of cured caulk and sealant after color selection has been made. Submit samples of sealant backing materials, minimum 12 inches (30.5 cm) long, and sealant bond breaker materials.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver products to the project site in their original unopened containers bearing the name of the manufacturer and brand and other information such as color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials. Store and handle products as recommended by the manufacturer to prevent damage and deterioration. Additionally, store sealants at a temperature between 40 degrees and 80 degrees F (4.4 degrees and 27 degrees C) and store sealant backing and bond breaker so they will not become damp, wet or frost covered.

1.6 WARRANTY. Provide installation warranty for a period of 5 years against defective materials and workmanship.

During the warranty period, restore defective Work to the standard of the Contract Documents without additional compensation, including all materials, labor, refinishing and other costs incidental to the Work. Within 24 hours after receipt of notice from the Engineer, inspect the Work and immediately repair leaks. Restore

Work found to be defective, as defined in the Contract Documents, within 10 days after receipt of notice from the Engineer.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Do not install exterior sealant in damp or rainy weather. Do not install interior or exterior sealants until after substrate surfaces have thoroughly dried. Do not install sealant when ambient temperature is below 40 degrees F (4.4 degrees C) unless approved in writing, with appropriate application procedures, by the sealant manufacturer.

Do not proceed with installation of joint sealers where joint widths are less than allowed by joint sealer manufacturer for application indicated. Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.

2.2 ACCEPTABLE MANUFACTURERS. Provide products manufactured by General Electric (silicone products), Pecora Corp., Tremco, Inc., Sonneborn Div. of ChemRex, Dow Corning Corp., or equal.

2.3 MATERIALS. Provide caulk, joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience. Provide color of exposed joint sealers indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's entire range of colors.

2.3.01 Elastomeric Joint Sealants (High Performance General Purpose Exterior): Provide manufacturer's standard chemically curing, elastomeric sealant of polysulfide, silicone or urethane base polymer which complies with ASTM C920 requirements, including Type, Grade, Class and Uses, subject to approval.

One-Part Mildew-Resistant Silicone Sealant should be Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated.

Single-component, silicone, elastomeric sealant shall comply with ASTM C920, Type S, Grade NS, Class 25, Use NT. Dow Corning "790", "791" or "795"; Pecora "890"; or equal.

Two component, polysulfide rubber elastomeric sealant to provide nonsag, nonsubmerged service shall be Bostik “Chem-Calk 200”, Pecora “GC-5”, Sonneborn “Sonolastic Polysulfide Sealant”, or an approved equal. For self-leveling use Bostik “Chem-Calk 250”, or equal.

Multi-component, urethane, elastomeric sealant complying with ASTM C920, Type M, Class 25, Use T, nonsubmerged service. Provide primer recommended by sealant manufacturer. For Grade NS, use LymTal International, Inc. “Iso-Flex 881” or approved equal. For Grade P, use LymTal International, Inc. “Iso-Flex 880GB”, Sonneborn “SL2”, Sonneborn “NP2”, or equal.

For multi-component, urethane sealant, comply with ASTM C920, Type M, Class 25, Use T, submerged service, NSF 61 approved. For Grade NS, use Polymeric Systems, Inc. “PSI - 270 Reservoir Sealant” or approved equal. For Grade P, use Polymeric Systems, Inc. “PSI - 270 SL Reservoir Sealant” Sonneborn “Polvsulfide Sealant”, or equal.

For two component, urethane sealant to provide nonsag, nonsubmerged service, use Bostik “Chem-Calk 500”, Tremco “Vulkem 227”, or Pecora “Dynatrol II”. For self-leveling, use Bostik “Chem-Calk 500”, Tremco “Vulkem 245”, Pecora “Urexpan NR-200”, or Tremco “THC-900”, Sonneborn “NP2”, or equal.

For single-component, silicone sealant complying with ASTM C920, for high humidity/moisture exposure use Dow Corning “786”; Pecora “898; Sonneborn “OMNIPLUS”, or equal.

2.3.02 Non-elastomeric Sealants. For (general purpose interior) Single-component, latex sealant complying with ASTM C834, use Pecora “AC-20 + silicone”; Tremco “Tremflex 834”; Sonneborn “Sonolac”, or equal.

2.3.03 Bath/Tile Sealant. For white silicone that meets ASTM C920, Uses M and A; single component, mildew resistant, use Dow Corning Trademate Tub Tile and Ceramic Sealant, Sonneborn “OMNIPLUS”, or equal.

2.3.04 Acoustical Sealants. For single-component, non-hardening synthetic rubber complying with ASTM C1311, use PTI “707” or “757”; Tremco “Acoustical Sealant”; Pecora “BA-98”; Sonneborn “200 Adhesive”, or equal.

2.3.05 Solvent-Release Curing Joint Sealants. Manufacturer’s standard one-part, nonsag, solvent-release-curing, acrylic terpolymer sealant complying with ASTM C920 for Type S; Grade NS; Uses NT, M, G, A, and, as applicable to joint substrates indicated, O; except for selected test properties which are revised as follows. Heat-aged hardness shall not exceed 40 to 50. Weight loss shall not exceed 15%. Maximum cyclic movement capability shall not exceed plus or minus 12 1/2%.

Acceptable products include “Mono 555”; Tremco Inc., or equal.

2.3.06 Preformed Foam Compression Sealant. Manufacturer’s standard preformed, pre-compressed, impregnated foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water repellent agent; factory-produced in pre-compressed sizes and in roll or stick form to fit joint widths indicated and to develop a watertight and airtight seal when compressed to the degree specified by manufacturer. Product should be permanently elastic, mildew-resistant, non-migratory, non-staining, compatible with joint substrates another joint sealers, subject to approval.

2.3.07 Solvent. Oil-free cleaning solvent (for example: toluene, xylene, methyl ethyl ketone, acetone, 50/50 mixture of isopropyl alcohol and water, and mineral spirits) as recommended by sealant manufacturer.

2.3.08 Primer. Where required, use a non-staining primer recommended by the sealant manufacturer.

2.3.09 Sealant Backing. Furnish sealant backing material for the application as recommended by the sealant manufacturer, of the following types:

Plastic Foam Joint Fillers: Preformed, compressible, resilient, non-waxing, non-extruding strips of flexible, non-gassing plastic foam of material indicated below; non-absorbent to water and gas; and of size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

Open Cell: Expanded open cell polyurethane shape compressed a minimum of 25 percent of its dimension at time of installation in the joint opening. Furnish Backer Rod Mfg., Inc. “Denver Foam”; Industrial Thermo Polymers Limited “TundraFoam”; or equal.

Closed Cell: Expanded closed cell polyethylene shape compressed no more than 25 to 33 percent of its dimension at the time of installation in the joint opening. Furnish Industrial Thermo Polymers Limited “ITP Standard Backer Rod”; Nomaco, Inc. “Green Rod”; W.R. Meadows, Inc. “Sealtight Kool-Rod”; or equal.

Foam Tape: Self-adhesive, rectangular shape, expanded open cell polyurethane or closed cell polyethylene, sized for the application and as manufactured by Williams Products Inc.; H-O Products Corp.; Norton Co.; or equal.

2.3.10 Elastomeric Tubing Joint Fillers. Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, non-absorbent to water and gas, capable of remaining resilient at temperatures down to –26 degrees F (-15 degrees C). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.

2.3.11 Bond Breaker. Heavy duty, 14 mil (0.4 mm) minimum thickness, colored, polyethylene or Teflon, self-adhesive bond breaker of type recommended by sealant manufacturer and suitable for conditions of usage. Liquid bond breaker is not permitted.

PART 3 – EXECUTION

3.1 INSPECTION. Examine joints indicated to receive joint sealers, with Installer present, for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance.

Inspect joint opening prior to sealant installation for proper installation of sealant backing or bond breaker, proper opening depth and proper substrate preparation, cleaning and (where required) priming.

3.2 PREPARATION. Protect the Work and adjacent construction against damage. Clean Work adjacent to joints free of smears of sealant as Work progresses. Protect surfaces difficult to clean with masking tape or other suitable means not injurious to surfaces being protected. Verify that in-place construction on which this Work is dependent is free of defects which may influence satisfactory completion and performance of the Work. Beginning of installation means acceptance of in-place construction.

3.2.01 Substrates. Prepare joint openings in substrate in conformance with manufacturer's written instructions, ASTM C1193, ASTM C919 for sealants in acoustical applications, and as specified.

Dry, sound and thoroughly clean sealant substrates are required when primer (where required by manufacturer for optimum adhesion) and sealant are installed. Allow concrete, masonry or other porous substrates wetted by rain or other sources of moisture to dry for at least 24 hours under good drying conditions before application of primer or sealant. Protect surfaces that have been cleaned from contamination by deleterious materials such as oil, dust and rain, until primer (where required) and sealant are applied.

Use cleaning solvents as recommended by the sealant manufacturer. Furnish containers for cleaning solvent storage that are clean, oil-free and suitable for use with the solvent.

3.2.02 Masonry, Concrete or other Porous Substrates. Remove loose particles, dirt, paint, foreign matter, and concrete curing compound by sandblasting, nylon bristle brush or other sealant manufacturer approved method not injurious to the substrate material and that will not change the appearance of the exposed surfaces adjacent to the sealant joint opening. Expose fine aggregate of concrete substrates to be sealed. Remove dust created by cleaning by repeated brushing with a soft bristle brush or by blowing dust from the substrate with oil-free compressed air.

Where indicated or specified, rake out mortar joints to width and depth indicated to receive sealant. Bring joints having excessive depth to proper depth with sealant backing specified. Rake out to proper depth, joints that are too shallow.

Clean sealant joint opening of mortar droppings and any other materials that affect finished sealant joint performance prior to installation of sealant backing material.

3.2.03 Metal Substrates. Remove oils, residues from forming processes, corrosion and oxide build-up by nylon bristle brush, chemical cleaners or other sealant manufacturer approved method. Following removal, clean the substrate surface using the two-cloth system with a clean, lint free, white cloth soaked in solvent which is poured, not dipped, onto the cloth, followed by wiping the substrate surface dry, with the second clean, lint free, dry, white cloth before the solvent evaporates. Change to clean rags frequently. Brush application of solvents is not permitted.

3.2.04 Coated Metal or other Non-Porous Substrates. Clean the substrate surface using the two-cloth system with a clean, lint free, white cloth soaked in solvent which is poured, not dipped, onto the cloth, followed by wiping the substrate surface dry with the second dry, clean, lint free, white cloth before the solvent evaporates. Change to clean rags frequently. Brush application of solvents is not permitted.

Clean organically coated (PVF, silicone-polyester, etc.) panels or other similar factory applied finishes with sealant and finish manufacturer approved solvent that is compatible with organic coating system.

3.2.05 Elastomeric Rubber and other Organic Substrates. Submit organic materials to sealant manufacturer for compatibility testing by ASTM C1311 and adhesion testing by ASTM C794.

Remove lubricants, release agents, dusting agents, and other materials from the substrate surface, using cleaning procedures based on the successful completion of the above testing, as provided in writing by the sealant manufacturer.

3.2.06 Primer. Apply primer, as recommended by the sealant manufacturer, only to previously cleaned substrate surfaces to which sealants will be applied. The preferred method for application is with a clean, lint-free cloth for non-porous substrates and a clean natural bristle brush for porous substrates. Apply primer to the cloth or brush by pouring; dipping is not permitted. Take adequate measures, such as masking joint opening edges, to prevent primer from being applied to the face of adjacent surfaces. Allow primer to cure as recommended by the sealant manufacturer before installation of sealant.

Prime only those substrate surfaces that can be sealed immediately after the recommended primer curing period to preclude dust, oil, rain, condensation or other deleterious conditions to contaminate primer.

3.2.07 Sealant Backing Material. Install sealant backing, of proper type and size, at proper depth in joint to provide specified joint dimensions. Place sealant backing into the joint to avoid lengthwise stretching, twisting, braiding or lapping. Provide continuity with tight butt joints. Install dry sealant backing immediately prior to installing sealant. Apply sealant with sealant backing in place unless otherwise indicated.

Install closed cell sealant backing using good practices to avoid compression in excess of that specified or puncturing of the sealant backing material.

If the sealant backing is to function as a temporary joint seal for weather protection or other reasons, for a period of time before sealant installation, remove the backing and replace it immediately prior to sealant installation with new sealant backing.

3.2.08 Bond Breaker. Install properly sized bond breaker tape so that the entire surface is covered. One tape may be lapped over another to achieve total coverage. Do not extend bond breaker tape onto the substrate surfaces to interrupt or prevent adhesion of the sealant to the substrate.

3.2.09 Joint Dimensions. Create joint opening depth (as measured at the sealant and substrate interface) for sealant contacting and bonded to substrate surfaces no less than 1/4 inch (6.4 mm) in depth. Minimum sealant depth at the mid-point of the joint width shall be 1/8 inch (3.2 mm).

Unless indicated otherwise on the drawings, for joint opening widths from 1/4 inch (6.4 mm) up to 1/2 inch (1.3 cm) wide, provide joint opening depth of 1/4 inch (6.4

mm); for joint opening widths over 1/2 inch to 3/4 inch (1.3 to 1.9 cm) wide, provide joint opening depth of one half the width; for joint opening widths over 3/4 inch to 2 inches (1.9 to 5.1 cm) wide, provide joint opening depth no greater than 3/8 inch (9.5 mm); and for joint opening widths exceeding 2 inches (5.1 cm), provide depth as determined by the sealant manufacturer.

Refer to the drawings for joint opening requirements.

3.3 INSTALLATION. Install sealant in conformance with the manufacturer's written instructions, ASTM C1193, ASTM C962 for elastomeric sealants, ASTM C804 for solvent release curing sealants, ASTM C790 for latex sealants, ASTM C919 for sealants in acoustical applications and as specified.

Do not apply sealant to damp, wet or frost covered substrates, sealant backing or bond breaker.

Dry-tool exposed sealant surface immediately using no lubricant such as soap and water. A lubricant is allowed, if permitted by the sealant manufacturer and is a solvent or similar type product as recommended in writing by the sealant manufacturer.

Where required or specified, to avoid smearing sealant on surfaces adjacent to joint opening, use masking tape or other suitable means and remove after tooling sealant surface and before sealant begins to cure. Organically coated (PVF, silicone-polyester, etc.) panels or other similar factory applied finishes shall be protected.

Use drop cloths to cover horizontal or other surfaces likely to receive sealant droppings during installation.

3.3.01 Sealant Backings. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability. Do not leave gaps between ends of joint fillers. Do not stretch, twist, puncture, or tear joint fillers. Remove absorbent joint fillers which have become wet prior to sealant application and replace with dry material.

Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.

Install compressible seals serving as sealant backings to comply with requirements indicated above for joint fillers.

3.3.02 Non-Sag or Gunnable Sealant. Apply non-sag sealant into joint opening with hand- or air-powered sealant gun so as to fill void completely. Use gun nozzle of proper size to fit joint opening.

Take care not to smear adjoining surfaces with sealant. Force sealant, by tooling, fully into joint opening and intimate contact with substrate surface. Tool exposed joint surface so that a slight concave surface is formed. Use of the sealant gun for tooling is not allowed.

3.3.03 Pourable or Self-Leveling Sealant. Apply self-leveling sealant to finish close to the joint opening surface without overflowing and to form a slightly concave joint surface. Where required due to slope or other conditions, install a non-sag formulation of the same sealant in accordance with the procedures specified for that sealant type.

3.3.04 Tooling of Nonsag Sealants. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

Provide concave joint configuration per Figure 6A in ASTM C962, unless otherwise indicated. Provide flush joint configuration per Figure 6B in ASTM C962, where indicated. Use masking tape to protect adjacent surfaces of recessed tooled joints.

3.3.05 Installation of Preformed Foam Sealants. Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, and to comply with sealant manufacturer’s directions for installation methods, materials, and tools which produce seal continuity attends, turns, and intersections of joints.

3.3.06 Cleaning. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.3.07 Protection. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage/deterioration occurs, cut out and remove damaged/deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

End of Section

SECTION 07950

FIRESTOPPING AND SMOKESTOPPING

PART 1 - GENERAL

1.1 SCOPE. This section includes firestopping in spaces between materials and all penetrations through fire barriers, where indicated on the drawings, including voids around pipes, ducts, conduits, and other openings, as required by authorities having jurisdiction.

This section also includes smokestopping in spaces between materials and all penetrations through smoke barriers, where indicated on the drawings, including voids around pipes, ducts, conduits, joints between smoke barriers, other construction, and other joints and openings, as required by authorities having jurisdiction.

1.1.01 Work Not Included. Repairing penetrations made in error and repairing penetrations which are too large to be sealed by the methods indicated; these are to be repaired using the original material of the construction.

1.1.02 Products Furnished but Not Installed. Sleeves which are an integral part of the firestopping assembly but which must be set by installer of other construction.

1.2 GENERAL.

1.2.01 Coordination. Prior to the start of work which involves cutting penetrations, conduct a meeting with installers of such work to identify fire and smoke barriers and required configurations of penetrations and to discuss the proper procedures and time schedule for cutting, patching, and sealing penetrations in such assemblies, with emphasis on avoiding unnecessary cutting and patching.

Perform firestopping and smokestopping work after completion of work, which penetrates fire and smoke barriers, but prior to covering up or eliminating access to the penetration. Coordinate with installers of such other work.

1.2.02 Governing Standards.

ASTM (American Society for Testing and Materials) E84 – Test Method for Surface Burning Characteristics of Building Materials.

ASTM E119 - Test Method for Fire Tests of Building Construction and

Materials.

ASTM E814 – Test Method for Fire Tests of Through-Penetration Fire Stops.

FM (Factory Mutual Engineering Corporation) – Fire Hazard Classifications.

FM P7825 – Approval Guide (with supplement I).

UL (Underwriters Laboratories, Inc.) - Fire Resistance Directory.

UL 263 – Fire Tests of Building Construction and Materials.

UL 723 – Test for Surface Burning Characteristics of Building Materials.

UL 1479 – Fire Tests of Through-Penetration Firestops.

WH (Warnock Hersey) – Directory of Listed Products.

1.2.03 Definitions.

Fire Barrier. Any wall, floor, ceiling, or roof which is indicated as having a fire-resistance rating.

Smoke Barrier. Any wall, floor, ceiling, or roof which is indicated as being designed to prevent passage of smoke and gases; may be indicated as "smoke barrier," "smoke partition," "smoke wall," etc.

Firestopping. A sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest the movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Company specializing in fire and smokestopping for projects of this size with a minimum of three years documented experience.

1.3.02 Testing. Testing shall have been conducted or witnessed by an independent testing agency acceptable to governing authorities.

Test methods shall comply with ASTM E814 and ASTM E119; as indicated for each

penetration seal.
Conduct tests with a measurably higher pressure inside the chamber than outside.
The listing of the assembly to be used in the current edition of either Underwriters Laboratories Inc. “Fire Resistance Directory” or Factory Mutual System “Approval Guide” will be considered evidence of acceptable testing.

A current evaluation report by BOCA Research and Evaluation Committee ("BOCA Research Report") will be considered evidence of acceptable testing:

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit manufacturer’s data on product characteristics, performance, limitations, and installation instructions. Include detailed instructions for repair and for modification due to changes in penetrating items.

1.4.02 Certifications. Certify products meet or exceed specified requirements.

1.4.03 Schedule of Firestopping. Provide complete list, for approval, of opening locations and sizes and penetrations to be sealed, indicating location, fire rating of penetrated assembly, identification of penetration seal to be used, fire rating of penetration seal, and evidence of acceptable testing.

1.4.04 Schedule of Smokestopping. Provide complete list, for approval, of opening locations and sizes and penetrations to be sealed, indicating location, construction of penetrated assembly, and identification of penetration seal to be used.

1.4.05 Preinstallation Inspection Report. Identify penetrations, which need to be repaired using the original material of the assembly.

1.4.06 Project Record Documents. Drawings showing locations of all fire and smoke barriers, the actual penetrations through them, and the manner in which they have been sealed; cross-referenced to maintenance data.

1.5 DELIVERY, STORAGE, AND HANDLING. Coordinate delivery of products to minimize storage time at site.

Deliver products to project site in original unopened containers bearing the name of the manufacturer, product name, type, and testing agency's identification mark. Store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide products manufactured by, Dow Corning Corporation, Hilti Corporation, 3M Fire Protection Products, Pecora

Corporation, United States Gypsum Company, or an approved equal.

2.2 MATERIALS.

2.2.01 Firestopping. It is the contractor's responsibility to determine the types of penetrations to be sealed and to select appropriate firestopping assemblies.

Provide penetration seal assemblies whose fire-resistance ratings have been determined by testing in the configurations required and which have fire-resistance ratings at least as high as that of the fire-rated assembly in which they are to be installed.

If a tested assembly is not available for a particular penetration configuration, modify the penetration configuration to suit available assemblies; do not modify assembly configuration except as specifically stated in the test report or as approved by the authority having jurisdiction.

Provide products which allow normal expansion and contraction movement of the penetrating item without failure of the penetration seal. They should emit no hazardous, combustible, or irritating by-products during installation or curing period and do not require special tools for installation.

2.2.02 Smokestopping. Use any gunnable or pourable joint sealant suitable for the application; use only fully curing types where accessible in the finished work. Provide products which allow normal expansion and contraction movement of the penetrating item without failure of the penetration seal. They should emit no hazardous, combustible, or irritating by-products during installation or curing period and do not require special tools for installation.

2.2.03 Primer. Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.

2.2.04 Installation Accessories. Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

PART 3 - EXECUTION

3.1 INSPECTION. Inspect all fire and smoke barriers for penetrations of any type; mark or otherwise identify all penetrations indicating action required whether it be: 1) repair; 2) firestopping; or 3) smokestopping.

Conduct inspection prior to covering up or enclosing walls or ceilings jointly with Engineer and authorized representative of authority having jurisdiction.
Submit a report detailing findings of inspection to the Engineer.

If the configuration of a particular penetration does not conform to the configuration necessary for the required firestopping assembly, notify the installer of the penetration for modification of the configuration to suit the assembly; do not use the firestopping assembly in other configurations except as specifically stated in the test report or as approved by the authority having jurisdiction.

3.2 PREPARATION. Prepare penetrations in accordance with the material manufacturer's instructions, prior to installing firestopping or smokestopping.

3.3 INSTALLATION. Install firestopping materials in exact accordance with manufacturer's instructions and the conditions of the testing; provide all accessory materials required and apply primer where recommended by manufacturer.

3.3.01 Application. Remove combustible forming materials, unless they are a required component of the tested assembly.

3.3.02 Cleaning. Clean up excess material adjacent to penetrations promptly; use methods and materials approved by the manufacturers of the penetration seals and of surfaces to be cleaned.

3.3.03 Protection. Protect adjacent surfaces from damage during installation.

Protect installed work during curing period from damage from construction operations using substantial barriers if necessary.

Repair damaged materials in accordance with manufacturer's instructions.

3.4 FIELD QUALITY CONTROL. Inspect completed installations for completeness and correct installation. If installed work is to be covered in completed work, inspect and obtain approval prior to covering. Obtain the approval of the authority having jurisdiction.

End of Section

INDEX

DIVISION 8 – DOORS AND WINDOWS

SECTION 08110

STEEL DOORS AND FRAMES

PART 1 – GENERAL

1.1 SCOPE. This section covers steel doors and frames.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society of Testing and Materials) A554 - Specification for Welded Stainless Steel Mechanical Tubing.

ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM C509 – Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.

AWS (American Welding Society) D9.1 - Sheet Metal Welding Code.

Mil. Spec. (Military Specification) DOD-P-21035A – Paint, High Zinc Dust Content, Galvanizing Repair.

NFPA (National Fire Protection Association) 80 – Standard for Fire Doors and Windows.

1.3 QUALITY ASSURANCE. All steel doors and frames shall comply with the building code enforced by the municipality paving jurisdiction and with NFPA 80. All fire door assemblies shall be welded by an approved agency. Ensure that approved agency classification markings for labeled hollow metal doors and frames are metal and mechanically applied with drive screws or rivets.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit Shop Drawings showing elevation and details of each frame and door type, location in building of each, conditions at openings with various wall thicknesses and materials, typical and special details of construction, method of assembling sections, location and installation requirements for hardware, size, shape and thickness of materials, joints and connections. Include hollow metal frames for prefitted doors specified elsewhere. Submit type and performance data for door louvers giving percentages of free area for louvers to be installed.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver doors and frames palleted, wrapped, or crated to provide protection during transit and job storage.

Inspect doors and frames on delivery for damage. Minor damages may be repaired by Contractor provided repaired items match new work including finish, and are acceptable to the Engineer responsible for installation. Otherwise, remove and replace damaged items as directed.

Store doors and frames at building site under cover. Place units on minimum 4 inch (10.2 cm) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4 inch (6.4 mm) spaces between stacked doors to promote air circulation.

1.6 WARRANTY. Warrant the Work for 2 years against defective materials or workmanship, or both, and against leakage, except where such leakage is caused by lightning, hurricane, tornado, hail storm or other unusual climatic phenomena of the elements, or failure of related work installed by other parties, or abuse or vandalism.

During the warranty period, the Contractor agrees to restore defective Work to the standard of the Contract Documents, including materials, labor, refinishing and other costs incidental to the Work. Within 24 hours after receipt of notice from the owner, the Contractor shall inspect the Work and immediately repair leaks in the Work. The Contractor agrees to restore Work found to be defective as defined in the Contract Documents within 10 days after receipt of notice from the Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Acme Steel Door Corp.; American Steel Products Corp.; Curries Co.; Macotta Manufacturing; Overly Manufacturing Co.; Pioneer Industries; Steelcraft; Trussbilt, Inc.; Windsor Door; or approved equal.

2.2 MATERIALS.

2.2.01 Steel Sheet shall be cold-rolled, complying with ASTM A1008; hot-rolled, complying with ASTM A1011, pickled and oiled; or galvannealed complying with ASTM A653, A25 coating designation, unless otherwise specified, mill phosphatized, and shall be free from surface or internal defects, and with clean smooth surfaces.

Steel sheet for doors, in addition to the above shall be stretcher leveled.

Steel for exterior doors and frames, and interior doors and frames indicated as A60 galvannealed including their anchors shall be ASTM A653/A653M, commercial quality, A60 coating designation, mill phosphatized.

Steel for doors and frames indicated as G90 shall be galvanized and be ASTM A653/A653M, commercial quality, and G90 coating designation.

2.2.02 Stainless Steel. Stainless steel tubes shall be ASTM A554

Flat sheet and plate shall be ASTM A666, Type 302 or 304, No. 4 finish, unless otherwise specified.

Filler metal for welding shall be the type recommended by the manufacturer of stainless steel.

2.2.03 Sound-Deadening Liner for Doors. For non-labeled doors, sound-deadening liner shall be rockwool or other approved synthetic resin based liner.

For labeled doors sound-deadening liner shall be as required by the labeling authority.

2.2.04 Louvers. Louvers for interior doors shall be sightproof, stationary type with inverted "V" blade or inverted "Y" blade at the option of the manufacturer; blades formed of not less than 20 gage (1.0 mm) steel sheets set at not more than 3 inch (7.6 cm) spacing; not less than 30 percent free air opening.

Louvers for exterior doors shall be stationary type "Z" blade design with insect screen; blades formed from not less than 20 gage (1.0 mm) galvanized steel sheets and spaced approximately 1-1/2 inches (3.8 cm) apart; bronze 14 x 18 inch (35.6 x 45.7 cm) mesh insect screen mounted to interior face of louver, complete with standard folded frame.

Louvers for labeled doors shall be labeled and having U.S.S. 18 gage (1.3 mm) steel adjustable blades with fusible link set for 135 degrees F (57.2 degrees C); 35 percent minimum free air opening.

2.2.05 Integral Seal. Shall be closed cell neoprene complying with ASTM C509.

2.2.06 Zinc-Rich Paint. Shall be ZRC Products Co., "Z.R.C." or other acceptable product complying with DOD-P-21035A.

2.2.07 Metal Gages. Metal gages for steel sheets and strips for hollow metal work shall be to manufacturer's standard, with minimums as follows:

Frames for doors and side lights:	
Exterior frames	14 ga. (1.9 m)
Interior frames	16 ga. (1.6 m)
Rough bucks	12 ga. (2.7 m)
Mullions	same as frame
Moldings	20 ga. (1.0 m)
Frames for borrowed lights:	
Frames and mullions	16 ga. (1.6 m)
Moldings	18 ga. (1.3 m)
Full flush doors (metal core reinforcement):	
Face sheets for interior doors	18 ga. (1.3 m)
Face sheets for exterior doors	16 ga. (1.6 m)
Core stiffener channels or "Z" member	20 ga. (1.0 m)
Optional core - continuous trusscore	28 ga. (0.5 m)

Moldings	18 ga. (1.3 m)

2.3 MANUFACTURER AND FABRICATION. Insofar as practicable, fabricate the Work at shop, ready for delivery and erection at building. Trial-fit Work that is not able to be completely fabricated in shop. Assemble at shop to insure proper assembly at building. Provide holes, connections, fastenings for and to work of other trades abutting, adjoining or intersecting the Work.

2.3.01 Welding. Welding shall comply with AWS D9.1. Fabricate the Work with all joints and connections continuously welded surfaces in alignment, straight and free from defects such as warp, or buckling. Unless indicated otherwise, make all corners square and edges sharp. Join molding neatly and weld. Dress all joints flush with base metal surface. Provide bracing necessary to support movable parts.

Provide concealed reinforcement of sheet or bar steel for hardware, including automatic devices, and other attached work, where and as required by conditions. Hinge reinforcement shall not be less than 3/16 inch (4.8 mm) thick by not less than 1-1/2 inches (3.8 cm) wide by not less than 6 inches (15.2 cm) longer than hinge. Reinforcement for other hardware and attached work shall not be less than 12 gage (2.7 mm) and of sufficient size to receive fastenings. Secure hinge, door closer and door holder reinforcements with at least 6 spot welds. Secure other reinforcement with at least 2 spot welds.

2.3.02 Hardware Preparation. Drill and tap Work as required for mortised hardware. Locate by template provided by manufacturer.

Prepare hollow metal door frames and hollow metal doors for finish hardware. Coordinate fitting of hardware on frames for doors specified in other Master Specification sections, which require factory fitting of hardware. Provide sinkages or mortises, as required, formed accurately to template so that mortised hardware will fit neatly into depressions, with hardware member surface flush with surface of door or frame, unless otherwise required.

Provide reinforcing plates, less drilling and tapping, for doors and frames to receive surface applied hardware, except push plates and kick plates.

Provide plaster guards or mortar boxes in back of hardware cutouts welded to frame.

Punch interior door frames to receive door silencers. For single door frames, provide for 3 silencers in lock side jambs. For double door frames, provide for one silencer for each leaf in frame head.

For double door frames with flush transom panels, provide continuous sponge neoprene silencer at transom rabbeted stop.

Provide necessary additional space, cut-outs, reinforcements and provisions for fastening in doors and frame heads to receive overhead door closers concealed in frame members.

Provide continuous hardware reinforcement for hinges for lead-lined doors.

2.3.03 Shop Painting. Remove oil, grease, sand, dirt and other foreign substances. After cleaning, chemically treat cold-rolled and galvanized metal surfaces to assure maximum paint adherence.

Touch up welds and abrasions in galvannealed and galvanized surfaces with zinc-rich paint.

For Primed Finish, apply dip or spray coat of rust-inhibitive metallic oxide or synthetic resin metal primer, baked on or oven-dried, to cold rolled ferrous metal surfaces which are smooth and free from irregularities and rough spots.

For Bituminous Paint Finish, in addition to primed finish, paint back surfaces of frames, reinforcing struts and other ferrous parts concealed by building construction one heavy coat of approved bituminous paint.

2.3.04 Hollow Metal Frames. Form frames for doors, transoms, side-lights, borrowed lights, interior glazed panels and other items indicated as being hollow metal of steel sheets. Fabricate frames as indicated. Vary forming from that indicated where special conditions necessitate changes from indicated details, as approved.

Unless otherwise indicated, provide combination type frames with integral buck, integral seal where indicated, jamb and trim, welded construction, with all contact edges of corner joints closed tight, and with trim faces mitered and continuously welded. Provide plaster flanges and Master #2246 keys for frames located in plastered walls. Seal joints in exterior frames watertight.

Provide mullion and transom bars in frames using closed or tubular construction with rabbets for doors, glass, and transom panels. Fasten mullions and transom bars at crossings and to jambs by butt welding. Reinforce joints between members with concealed clip angles of same metal gage as frame.

Reinforce heads of frames in non-load bearing masonry partitions less than 8 inches (20.3 cm) thick. Unless otherwise indicated, provide continuous channel head reinforcing formed from not less than 12 gage (2.7 mm) steel sheet, of width and depth the greatest dimensions possible to suit frame head condition, and welded to back of frame at head. Other methods of reinforcing may be employed subject to the approval of the Engineer. Reinforcing at stainless steel frames shall be stainless steel members as required.

Provide cabinet jambs consisting of rough bucks with applied combination type frame with integral or applied trim as indicated. Provide jambs for required wall openings that do not extend down to floor level which entirely surround opening. Fabricate rough bucks in channel shape with web of same depth as wall thickness and flanges 1/4 inch (6.4 mm) less than frame depth. Cope and weld corners of bucks that do not extend to ceiling.

2.3.05 Wall and Floor Anchors for Hollow Metal Frames. Provide metal anchors of shape and sizes required for adjoining wall construction. Fabricate wall anchors of steel, not less than 18 gage (1.3 mm).

For frames set in masonry, except labeled openings, use adjustable, flat or perforated or corrugated, T-type sliding anchors, 3 inches by 10 inches (7.6 cm by 25.4 cm) long, with anchor head of width and length to fill void in back of frame. Locate anchors on each jamb near top and bottom of frame and at intermediate points not over 24 inches (61.0 cm) apart.

For labeled openings, use anchors approved by the Testing Agency as appropriate for type of wall construction. At new masonry walls, use masonry "tee" anchors. At previously placed concrete or masonry walls, provide approved spacers. Locate anchors in accordance with Testing Agency requirements.

For frames set in metal stud partitions, use metal jamb anchor clips, notched and punched type at truss type studs, and with turned down edge at channel type studs. Weld clips to inside of each jamb. Provide anchors, which are suitable for type of metal studs specified under Master Specification Section 05400, Cold-Formed Framing. Provide 4 anchors per jamb for frames 7 feet (2.13 m) or less in height. Locate anchors immediately above and below top hinge reinforcement and above other hinge reinforcements. Locate anchors on strike side directly opposite the anchors on the hinge side. For frames over 7 feet (2.13 m) high, use additional anchors per jamb spaced not more than 18 inches (45.7 cm) apart.

For frames set in previously placed concrete or masonry walls, provide flat-head machine bolt and shield anchors through frame stops. Provide steel spacer or plate reinforcing welded to frame behind stop at each anchor location. Locate anchors on each jamb near top and bottom of frame and at intermediate points not over 24 inches (61.0 cm) apart. Provide continuous rough buck or plate welded to legs of frame.

For frames set in steel subframes, provide flat-head machine bolt through frame stops. Provide steel spacer or plate reinforcing welded to frame behind stop at each anchor location. Locate anchors on each jamb near top and bottom of frame and at intermediate points not over 24 inches (61.0 cm) apart. Provide continuous rough buck or plate welded to legs of frame.

For frame jambs, and mullions extending to floor, use floor anchor clips of not less than 10 gage (3.5 mm) steel, with 2 holes for anchoring to floor, and welded to trim flanges. Where separate topping is indicated, extend door frames and mullions to concrete subslab. Provide temporary removable steel spreaders or shipping bars across bottom of frames and tack weld to jambs and mullions.

2.3.06 Moldings. Provide moldings with hollow metal frames having openings for glass, panels and other locations where trim moldings are indicated. Fabricate glazing moldings of steel, removable type, square or rectangular, suitable for 1/4 inch (6.4 mm) thick glass assembled with butted corners, and secured with countersunk oval-head Phillips machine screws, uniformly spaced not more than 12 inches (30.5 cm) apart.

Fabricate moldings for panels other than glass of shape indicated, suitable for panel thickness indicated. Assemble molded shapes with mitered corners and square or rectangular shapes with butted corners. Secure as specified for glazing moldings.

Provide stainless steel moldings and accessories at stainless steel frames.

2.3.07 Stops. Provide terminated hospital sanitary stops on interior hollow metal door frames in locations indicated. Stops shall be terminated 4 inches (10.2 cm) above finished floor. Cut stops at 45 degrees and close end of stop flush. Cover bottom of frame with steel filler plate welded in place.

2.4 HOLLOW METAL DOORS. Fabricate hollow metal doors of full flush door construction, unless indicated to be stile and rail door construction.

2.4.01 Full Flush Door Construction. Construct doors of 2 outer steel sheets with edges continuously welded and finished flush, without visible seams or joints on door faces or edges. Reinforce doors with metal core framing consisting of interlocking steel channels, or Z-shaped members, placed vertically and extending through full door height, spaced not more than 6 inches (15.2 cm) on centers and spot-welded not more than 3 inches (7.6 cm) on centers to interior surfaces of outer sheets. Reinforce tops and bottoms of doors horizontally along the full width of door by steel channels spot welded to outer sheets. Provide weep holes in bottom channel. Fill spaces between metal core framing members with approved sound-deadening liner.

As an optional framing core inner core may be continuous truss formed from not less than 28 gage (0.47 mm) sheet metal and spot-welded to interior surfaces of outer sheets not more than 3 inches (7.6 cm) on centers horizontally and vertically over entire surface on both sides. Fill spaces with approved sound-deadening liner.
2.4.02 Door Clearances. For non-labeled doors, provide 3/32 inch (2.4 mm) clearance at jambs and heads, 1/8 inch (3.2 mm) at meeting stiles of pairs of doors, and 3/4 inch (1.9 cm) at bottom, including thickness of resilient floor covering. Labeled doors shall be in accordance with NFPA 80.

2.4.03 Stile Edges. Beveled at 1 to 16 slope, unless otherwise specified.
Lock stile edges for double-acting doors shall be rounded.

2.4.04 Edge Closures. Top and bottom edges of exterior hollow metal doors shall be closed with flush cap to produce a weatherseal.

Top and bottom edges of interior doors where indicated shall be closed and filled flush to provide a sanitary surface.

Provide closure as part of door construction or by the addition of inverted steel channels or other suitable shapes welded to face.

2.4.05 Glass Openings. Provide open panels in doors for glazing, of sizes indicated. Provide rabbets as part of door construction or by the addition of steel stops. Secure glass with removable glazing moldings on room side for doors facing corridors, on interior side for exterior doors. Fabricate glazing moldings of steel, square or rectangular stops, suitable for 1/4 inch (4 mm) glass, assembled with butted corners, and secured with countersunk oval-head Phillips machine screws spaced not more than 9 inches (22.9 cm) apart.

Provide metal louvers in doors as indicated, built in as part of door without the use of overlapping moldings on the surface of door facing sheets.

2.5 ACCESSORIES. Labeled hollow metal door and frame required by the Testing Agency for each fire class of opening, shall take precedence over project details and specifications, except when the Project Specifications require thicker gages than the Testing Agency for labeled doors and frames. In the case of an inconsistency between Testing Agency's requirements and the requirements indicated or specified, or both, submit the matter to the Engineer for adjustment before fabricating such work. Rated construction without label will not be accepted.

For hollow metal doors and frames, including transom panels, in labeled openings, provide the Testing Agency's classification marking for the fire class of opening indicated.

Where authorities with jurisdiction over the Project require deviation from the Testing Agency's requirement for latching device, reinforce doors and frames for surface mounted exit device.

Furnish astragals for all pairs of labeled doors, all pairs of doors in fire-rated partitions, and all pairs of exterior doors.

PART 3 – EXECUTION

3.1 INSTALLATION. Install hollow metal work in correct locations, in alignment, plumb and to true planes. Make breaks, angles and corners square with walls. Where coordination with adjoining work is necessary, take job measurements. Installation shall be in accordance with approved Shop Drawings.

Install hollow metal frames prior to construction of enclosing walls and ceilings. Brace frames securely until permanent anchors are set. Anchor bottom of frames with anchor bolts and lead expansion shields, or with drop-in expansion bolts. Build wall anchors into walls, or secure wall anchors to adjoining construction. Provide required wedging or blocking for frames. Remove and reinstall frames, which exceed the recommended tolerances.

Provide steel shims required under floor anchors.

End of Section

SECTION 08120

ALUMINUM DOORS AND FRAMES

PART 1 – GENERAL

1.1 SCOPE. This section covers aluminum doors and frames.

1.2 GENERAL.

1.2.01 Governing Standards.

AA (Aluminum Association) CA-92 - Care of Aluminum

AAMA (American Architectural Manufacturers Association) 605.2 - Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

ASTM (American Society for Testing and Materials) A36/A36M - Specification for Carbon Structural Steel.

ASTM B26/B26M - Specification for Aluminum-Alloy Sand Castings.

ASTM B108 – Specification for Aluminum-Alloy Permanent Mold Castings.

ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B221 – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

AWS (American Welding Society) C1.1 – Recommended Practices for Resistance Welding.

NAAMM (National Association of Architectural Metal Manufacturers) Specifications for Rubber-Like Gasket Materials.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. Provide aluminum doors and frames produced by a single manufacturer with not less than 5 years of documented experience in the fabrication of assemblies of the type and quality required.

1.3.02 Installer Qualifications. Entrances shall be installed by a firm that has not less than 5 years of documented experience in the installation of systems similar to those required.

1.3.03 Testing. Demonstrate compliance with performance requirements by testing according to the test methods indicated.

Standard for Air Infiltration Testing shall be per ASTM E283. Report result as cubic feet (0.0283 cubic meters) per minute per unit of measurement indicated, at pressure differential indicated.

Standard for Condensation Resistance Testing shall be per AAMA 1503.1. Report result as CRF.

Standard for Thermal Transmission Testing shall be per AAMA 1503.1. Report result as U-value (Btu per hr per sq ft per degree F).

1.3.04 Tolerances. Design exterior assembles shall comply with the following performance criteria:

> Air infiltration for pairs of doors shall not be more than 1.0 cfm per linear foot (929 cu cm per minute per linear cm) of crack. In addition, for each door there shall not be infiltration of more than 0.06 cfm per square foot (1.83 cu cm per sq minute per sq cm) of fixed area.
>
> Condensation resistance for door frames shall be 45 or higher.
>
> Thermal transmittance (U-Value) for door frames shall be no more than 0.65.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. The Contractor shall submit shop drawings indicating layout and elevations, sections, thickness and gage of metals, fastening, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, corner post details and erection details. He will also submit manufacturer's material specifications, drawings of standard components, and installation recommendations.

1.4.02 Samples. Submit samples of finish for exposed aluminum surfaces, applied to sample of each alloy to be used approximately 6 inches (15.2 cm) long.

1.5 DELIVERY, STORAGE AND HANDLING. Protect the Work and materials from damage during transportation to the project site, storage at site and during progress of the Work until completion. Store units upright on pieces of lumber in a dry location and under cover.

1.6 WARRANTY. Warrant the Work for 2 years against defective materials or workmanship, or both, and against leakage, except where such leakage is caused by lightning, hurricane, tornado, hail storm or other unusual climatic phenomena of the elements, or failure of related work installed by other parties, or abuse or vandalism.

During the warranty period, the Contractor agrees to restore defective Work to the standard of the Contract Documents, including materials, labor, refinishing and other costs incidental to the Work. Within 24 hours after receipt of notice from the owner, the Contractor shall inspect the Work and immediately repair leaks in the Work. The Contractor agrees to restore Work found to be defective as defined in the Contract Documents within 10 days after receipt of notice from the Owner.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Take field measurements to verify or supplement dimensions indicated. Be responsible for accurate fit of the Work.

2.2 ACCEPTABLE MANUFACTURERS. Provide product of PPG Industries, Inc.; Tubelite Architectural Systems; Kawneer Co.; Cupples Products, Inc.; Flour City Architectural Metals; General Bronze Architectural Products; or approved equal.

2.3 MATERIALS.

2.3.01 Aluminum. Extruded bars, rods, shapes and tubes shall be ASTM B221, 6063 alloy, unless otherwise specified.

Flat sheet and plate shall be ASTM B209, 1100, 3003 or 5052 alloy, unless otherwise specified.

Aluminum castings shall be ASTM B108 for permanent mold castings, and B26, Class 25, for sand castings.

2.3.02 Fasteners. Screws, nuts, washers, bolts, rivets, anchors, and other miscellaneous fastening devices used in fabrication of the work shall be stainless steel and of sufficient size and strength to perform the function for which they are used. Exposed fasteners shall be finished to match aluminum finish.

2.3.03 Steel. Structural steel shapes and bars shall be ASTM A36.

2.3.04 Glazing Gaskets. Shall be EPDM complying with NAAMM "Specifications for Rubber-Like Gasket Materials", of configuration recommended and as furnished by the manufacturer of the aluminum work for a watertight installation.

2.4 MANUFACTURERS AND FABRICATION. Welding shall comply with AWS C1.1.

2.4.01 Aluminum Doors. Door type will be narrow stile with glazed opening, single or in pairs and in size as indicated. Width of stiles and top rail shall be 2 inches (5.1 cm) minimum.

2.4.01.1 Construction. Stiles and rails shall be extruded aluminum tubular sections 1 3/4 inches (4.4 cm) deep with 1/8 inch (3.2 mm) nominal wall thickness. Width of bottom rail shall be 6 inches (15.2 cm) nominal. Door leaf shall be equipped with an adjustable mechanism located at the top rail near the lock stile, which will provide for minor clearance adjustments after installation.

Doors will be reinforced and through-bolted, with joints made by mechanical fastening or by concealed welding and mechanical fastening. Mechanical joints shall be accurately milled to a hairline joint and provide controlled water weepage.

2.4.01.2 Single-Acting Doors. Stiles for single-acting doors shall be beveled. Meeting stiles for pairs of single-acting doors shall be rounded with mortised weatherstripping in one stile.

2.4.01.3 Weatherstripping. Weatherstripping mortised in stiles shall be polypropylene pile in aluminum or stainless steel housing, adjustable and replaceable.

2.4.01.4 Hardware Cutouts and Reinforcing. Provide cutouts, recesses, mortising, or milling operations required for finish hardware, including automatic devices, accurately to templates. Provide backing plate reinforcing as required to insure adequate strength of connection.

2.4.01.5 Glazing Shapes shall be extruded aluminum, square stop design. Stops on exterior side of door shall be lock-in tamper-proof type.

Glazing beads shall be snap-in type with glazing gasket designed for 1/4 inch (6.4 cm) thick glass. Exposed screws will not be permitted.

2.4.01.6 Location of Hardware. Refer to Master Specification Section 08710, Finish Hardware.

2.4.02 Aluminum Frames. Fabricate principal parts of frames for aluminum doors of extruded aluminum tubular sections not less than 1/8 inch (3.2 mm) nominal wall thickness, and not less than width and depth indicated.

Door frames in curtain wall openings: extruded aluminum sections designed to fit into glazing recess of curtain wall members.

2.4.02.1 Construction. Construct the Work to provide for thermal movement based on 100 degree F (37.8 degrees C) temperature differential, to withstand wind loads normal to plane of door of 25 psf (122.0 kg/sq m) positive and negative pressures with maximum deflection limited to 3/4 inch (1.9 cm) or 1/175 of the clear span, whichever is the least, and to assure neat appearance. Fabricate joints to remain flush and hairline tight.

Provide steel members, as may be required for additional reinforcement of aluminum door frames, as an integral part of the prefabricated units. Provide frames with anchors and reinforcement for door hinges, locks and other finish hardware items.

2.4.02.2 Glazing Provisions. Provide face clearance from rabbet or glazing bead to glass of 1/8 inch (3.2 mm) minimum all around. Provide bite of not less than 3/8 inch (9.5 mm) for glass size up to 100 united inches (2.5 united meters), and not less than 1/2 inch (1.3 cm) for glass size over 100 united inches (2.5 united meters).

2.4.02.3 Weatherstripping. Weatherstrip door heads, jambs and meeting stiles Weatherstripping in door stops shall be extruded EPDM.

2.4.02.4 Accessories. Furnish aluminum trim, closures, and other components necessary for the complete installation of the Work. Use extruded aluminum shapes where possible.

Minimum thickness of brake metal, if used shall be 0.0641 inch (1.63 mm)
Provide weathertight closures to interface with curtain wall members.

2.4.03 Aluminum Finish. Provide organic finish to match curtain wall if applicable.

Insulate aluminum which will come in contact with concrete, masonry, wood, or dissimilar metals (except stainless steel, white bronze, or solid zinc) by application of heavy brush coat of alkali resistant bituminous paint or zinc chromate prime paint.

PART 3 – EXECUTION

3.1 INSTALLATION. Install the Work in accordance with manufacturer's printed directions and the approved Shop Drawings. Set members plumb, level, and true in openings. Fastenings shall be concealed.

3.1.01 Setting. Set aluminum doors in alignment, plumb, straight and in true planes. Refer to specifications or installation of finish hardware. Seal frames in curtain wall openings with glazing gaskets. Anchor framing members to adjoining or adjacent construction as indicated on details and approved Shop Drawings. Drill and tap steel and other work for the attachment of framing members, trim and accessories.

3.1.02 Hardware Adjustments. Before final acceptance of building, check and readjust the operating hardware. Leave the Work in complete and operating condition.

3.1.03 Cleaning. Before final acceptance, thoroughly wash finished surfaces with clean water and soap, and rinse with clean water in accordance with AA CA-92. Do not use acid solutions, steel wool or other harsh abrasives. Clean or restore aluminum surface finishes, which have been stained or discolored in accordance with AA CA-92 and the aluminum finish manufacturer's recommendations. Replace stained, discolored, and abraded components that cannot be repaired with new units.

3.2 MAINTENANCE. Submit manufacturer’s maintenance instructions for finished materials.

End of Section

SECTION 08130

STAINLESS STEEL DOORS AND FRAMES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS
- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
- A. This Section includes the following:
  1. Stainless Steel doors.
  2. Stainless Steel door frames.
  3. Stainless Sidelight frames
  4. Stainless Borrowed-light frames.

- B. Related Sections include the following:
  1. Division 4 Section "Unit Masonry Assemblies" for installing anchors and grouting frames in masonry construction.
  2. Division 5 Section "Formed-Metal Fabrications" for customized hollow-metal work other than doors, panels, and frames.
  3. Division 8 Section "Door Hardware (Scheduled by Naming Products)" for door hardware and weather stripping.
  4. Division 8 Section "Door Hardware (Scheduled by Describing Products)" for door hardware and weather stripping.
  5. Division 8 Section "Glazing" for glass in glazed openings in doors and frames.

1.3 REFERANCES
- A. ANSI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcing.
- B. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- C. ASTM E 90-90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
- D. ASTM E 413 - Classification for Rating Sound Insulation.
- E. UL10c - Positive Pressure Fire Test of Door Assemblies
- F. ASTM E 152 - Standard Methods of Fire Tests of Door Assemblies.
- G. AWS D9.1 - Sheet Metal Welding Code.
- H. NAAMM Metal Finishes Manual.
- I. SDI 100 - Recommended Specifications Standard Steel Doors and Frames.
- J. SDI 105 - Recommended Erection Instructions for Steel Frames.

1.4 SUBMITTALS
- A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description,

construction details, label compliance, sound and fire-resistance ratings, and finishes.

B. Shop Drawings: Show the following:
1. Elevations of each door design.
2. Details of doors including vertical and horizontal edge details.
3. Frame details for each frame type including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, accessories, joints, and connections.
7. Coordination of glazing frames and stops with glass and glazing requirements.

C. Samples for Verification: For each type of exposed finish required, prepare a sample not less than 3 by 5 inches (75 by 125 mm) and of same thickness and material indicated for final unit of Work.

D. Door Schedule: Use same reference designations indicated on Drawings in preparing schedule for doors and frames.

E. Oversize Construction Certificates: For door assemblies required to be fire-protection rated and exceeding size limitations of labeled assemblies.

1.5 QUALITY ASSURANCE

A. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage.

B. Inspect doors and frames on delivery for damage, and notify shipper and supplier if damage is found. Remove and replace damaged items.

C. Store doors and frames at building site under cover. Place units on minimum 4-inch-(100-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) spaces between stacked doors to permit air circulation and ventilation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Steel Doors and Frames
   a. Stainless Doors Incorporated
   b. Next Door Company
   c. Stiles Custom Metal Inc.
   d. Kawneer

2.2 MATERIALS

A. Stainless Steel Type:
1. Steel: ASTM A 167, commercial quality type #316 stainless steel.

B. Finish:
1. Finish: No. 8 High Luster Mirror

C. Weldments: Exposed spot welds or other weld marks on exposed surfaces are not acceptable. Grind exposed welds smooth, and repolish to match specified and surrounding finishes.

2.3 DOORS

A. Fabricate products in accordance with industry standards and with Architects contract documents.

B. Door shall be integrally manufactured using face skins of prime stainless steel.
No cladding will be allowed.

C. All internal components, reinforcements and anchorages, shall be fabricated from
stainless steel, the same type as the face skins.

D. Fabricate in compliance with referenced standards, except where exceeded by the requirements of this specification.

E. Fabricate products with welded joints ground smooth and blend to match existing or adjacent surfaces.

F. Fabricate products with weld, bolt, tab and slot, screwed, adhesives and adhesive tape as approved in accordance with product performance to NFPA 80, HMMA 860, ASTM E152, UL10C and NSF testing as per manufacturer's documented testing approvals.

2.4 STILE & RAIL DOOR FABRICATION:

A. Door stiles and rails to be 16 gauge.

B. Door thickness to be 1 ¾ inches.

C. Door edges beveled 1/8" over 2'.

D. Stiles to be tubing type construction with 6" minimum wide faces.

E. Top Rail to be tubing type construction with 6" minimum faces.

F. Bottom Rail to be tubing type construction 10”.

G. Center Rail (if required) to be tubing type construction with 6" minimum wide face.

H. Tubes shall be joined with face welds ground and polished smooth to blend and match adjacent surfaces. Colored and some textured/patterned stainless steels will have visible hairline face miter seam.

I. All corners, joints, and intersections to be welded, ground smooth, refinished and re-polished to blend and match existing or adjacent surfaces.

2.5 REINFORCEMENT FABRICATION:

A. Reinforcements for stile and rail doors shall be the same type of stainless steel as stiles and rails. Other materials such as galvanized or cold or hot rolled steels will not be acceptable.

B: Door and Frame Reinforcements:
1. Hinge reinforcements - 1 1/4 inches wide x 10 inches long x 3/16 inch thick stainless steel.
2. Pivot reinforcements - shall be 12 gauge and as per hardware manufactures template.
3. Strike reinforcements - 14 gauge stainless steel.
4. Closer reinforcements – reinforce as required.

5. Surface hardware reinforcements - reinforce as required.

C: Weld reinforcements so no weld marks are visible on any exposed surface.

D. Vision Lite Systems: Manufacturer's standard kits consisting of glass lite moldings to accommodate glass thickness and size of vision lite indicated.

2.6 FRAMES

A. Frame Construction, General: Comply with standards referenced for doors, above.
   1. Door frames: Miter or butt trim faces and join with continuous trim face welds. Trim face welds to be ground smooth, refinished and re-polished to achieve specified finish. Miter or butt stops.

B. Frame Gage:
   1. Interior frames, 16 gage; exterior frames, 14 gage.

C. Floor Anchors.: one per jamb, minimum 14 gauge angle with two 3/16-inch diameter holes in floor clip for bolting to floor; secured to back of frame. Weld or burn marks on the exposed faces will not be acceptable.

D. Jamb Anchors in Masonry Partitions: Masonry tee anchors, minimum 16 gage with 2 inch x 10-inch legs.
   1. Up to 60 inches high: 2 jamb anchors.
   2. Over 60 up to 90 inches high: 3 jamb anchors.
   3. Over 90 up to 96 inches high: 4 jamb anchors.
   4. Over 96 inches high: 4 jamb anchors plus 1 for each 24 inches or fraction thereof over 96 inches.

   Note: Weld or burn marks on the exposed faces will not be acceptable.

E. At existing concrete and masonry partitions provide anchors suitable for the wall conditions.

F. Jamb Anchors in Stud Partitions: Zee-shaped clip, minimum 16 gage, secured to back of frame.
   1. Up to 60 inches high: 2 jamb anchors.
   2. Over 60 up to 90 inches high: 4 jamb anchors.
   3. Over 90 up to 96 inches high: 5 jamb anchors.
   4. Over 96 inches high: 5 jamb anchors plus 1 for each 24 inches or fraction thereof over 96 inches.

Note: Weld or burn marks on the exposed faces will not be acceptable.

G. Door and Frame Reinforcements for Builder’s Hardware:
   1. Hinge reinforcements: 1-1/4 inch x. 10 inches long x 3/16-inch thick, stainless steel.
   2. Strike reinforcements: 14 gage stainless steel.
   3. Closer reinforcements: gage stainless steel.
   4. Surface hardware reinforcements: gage stainless steel.
   5. Dust covers: At frame hinge preps, ¼ inch thick closed cell polyurethane foam with acrylic self-adhesive backing or minimum 22

gage stainless steel; minimum 22 gage stainless steel provided behind all other mortised hardware cutouts.
Note: Weld or burn marks on the exposed faces will not be acceptable.

H. Fabricate all components for doors and frames from stainless steel. Other types of steel, or non-stainless steel will not be acceptable.

I. Welding: Execute weldments such that no weld marks are visible on any exposed surface, Comply with AWS D9.1. Perform welding with gas tungsten arc (TIG) equipment, alloyed 308 stainless welding rods. Maintain proper welding temperature to avoid discoloring adjacent metal. Clamp components in appropriate jigs to avoid distortion and warpage. Discolored, distorted, or warped work will not be accepted.

J. Carton or crate doors to prevent damage in shipping and handling. Apply PVC film or equivalent material to protect against damage after delivery and removal from shipping crates.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

1. Except for frames located in existing walls or partitions, place frames before construction of enclosing walls and ceilings.
2. In masonry construction, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
3. In existing concrete or masonry construction, provide at least three completed opening anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices.
4. In metal-stud partitions, provide at least three wall anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Attach wall anchors to studs with screws.
5. For existing gypsum board partitions, knock-down, drywall slip-on frames are acceptable.
6. Install fire-rated frames according to NFPA 80.
7. For openings 90 inches (2286 mm) or more in height, install an additional anchor at hinge and strike jambs.

C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.

1. Fire-Rated Doors: Install within clearances specified in NFPA 80.
2. Smoke-Control Doors: Install to comply with NFPA 105.

3.2 ADJUSTING AND CLEANING

A. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

End of Section

SECTION 08300

OVERHEAD DOORS

PART 1 - GENERAL

1.1 SCOPE. This section includes miscellaneous overhead doors, including sectional, overhead doors, and roll-up or coiling doors and includes all accessories and appurtenances.

Location for sectional overhead doors are indicated on the drawings.

1.2 GENERAL.

1.2.01 Coordination. The anchors installed in masonry for support of overhead door section units are furnished but not installed under this section. Coordinate and schedule the installation of masonry anchors for support of overhead doors with masonry trade.

Furnish setting drawings, templates, and manufacturer's instructions for anchor installation to trades executing the work.

1.2.02 Governing Standards.

AHA (American Hardboard Association) A135.4 – Basic Hardboard.

ANSI/DASMA (Door & Access Systems Manufacturers Association) 102.

ASTM (American Society for Testing and Materials) A36/A36M – Specification for Carbon Structural Steel.

ASTM A47/A47M – Specification for Ferritic Malleable Iron Castings.

ASTM A48 – Specification for Gray Iron Casting.

ASTM A53/A53M – Pipe, Steel, Black and Hot-dipped, Zinc-coated, Welded and Seamless.

ASTM A283/A283M – Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

ASTM A153/A153M – Specification for Zinc coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A653/A653M – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.

ASTM A666 – Specification for Annealed or Cold-Worked Austentic Stainless Steel Sheet Strip Plate and Flat bars.

ASTM A924/A924M – Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy with Improved Formability.

ASTM B209 – Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B221 – Aluminum and Aluminum-Alloy Extruded Bar, Rods, Wire, Profiles, and Tubes.

ASTM E330 – Test method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

AWS (American Welding Society) D1.1 – Structural Welding Code – Steel.

Fed. Spec. TT-P-25E – Printer Coating, Exterior (Undercoat for Wood, Ready-Mixed, White and Tints).

Fed Spec. TT-P-641G – Primer Coating, Zinc Dust-Zinc Oxide (for Galvanized Surfaces).

NFPA (National Fire Protection Association) 70 – National Electrical Code.

NFPA 80 – Fire Doors and Windows.

PS 1 – Construction and Industrial Plywood.

WCLB (West Coast Lumber Inspection Bureau) – Standard Grading Rules.

NEMA (National Electrical Manufacturers Association) MG 1 – Motors and

Generators.

NEMA (National Electrical Manufacturers Association) 250 – Enclosures for Electrical Equipment (1000 Volts maximum).

NEMA (National Electrical Manufacturers Association) ICS 2 – Standards for Industrial Control Devices, Controllers and Assemblies.

UL (Underwriters Laboratories, Inc.) – Building Materials Directory.

UL 325 – Building Materials Directory.

UL 325 – Door, Drapery, Gate, Louver, and Window Operators and Systems.

WH (Warnock Hersey) – Directory of Listed Products.

1.3 QUALITY ASSURANCE. Furnish overhead door units by one manufacturer for entire project for each type of overhead door specified. Perform work in accordance with ANSI A216, for sectional doors and in accordance with manufacturer's instructions for roll-up or coiling doors.

Sectional overhead doors shall comply with ANSI/DASMA 102.

For wind loading sectional overhead doors shall comply with ANSI/DASMA 102 wind loading criteria. Roll-up or coiling doors shall be designed to withstand wind/suction load of 20 psf (97.6 kg/sq m), with maximum deflection of 1/20, and without damage to door or assembly components.

Doors with motor operators shall comply with requirements of UL 325.

1.3.01 Manufacturer Qualifications. Company specializing in manufacturing products specified in this section with minimum five years experience.

1.3.02 Installer Qualifications. Company specializing in performing work of this section with minimum five years experience approved by manufacturer.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit fully dimensioned and detailed drawings showing complete installation with components, materials and finishes, and accessories indicated, including wiring diagnosis, control items and wiring.

Submit manufacturer's technical information and installation instructions to demonstrate that precuts comply with contract documents.

Submit door operation instructions and maintenance data for each door type.

1.4.02 Certifications. Manufacturer shall submit written certification, indicating doors comply with specified design criteria in ANSI/DASMA 102 for sectional overhead doors and requirements specified herein for roll-up or coiling doors and defining thermal performance.

1.4.03 Samples. Submit two door slots 12 x 12 inch (30.5 x 30.5 cm) in size illustrating shape, color and finish texture.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide products from Cornell Iron Works, Inc., Mahon Door Corp, Overhead Door Corp., Raynor Garage Doors, Wayne-Walton Corp. or an approved equal.

2.2 MATERIALS. Galvanized Steel shall be ASTM A653 or ASTM A446 Class A or commercial quality steel sheets, ASTM A526; minimum yield point, 33,000 pounds per square inch; gage as indicated.

Steel bars and structural shapes shall be hot-rolled from new billet steel complying with ASTM A36.

Galvanized coating shall be ASTM A525; minimum G90 zinc coating where indicated.

Paint shall be metal primer; Manufacturer's standard epoxy primer.

2.2.01 Steel Sectional Overhead Door. Shall be "Thermacore Insulated Steel Door" from Overhead Door Corporation or approved equal.

Wind resistance shall comply with ANSI/DASMA 102. Thermal resistance shall have R-value of 14.86. Insulation shall be polyurethane foam. Door section material shall be 20 gage (1.0 mm) galvanized steel. Door section design shall be a flush profile. Galvanized coating shall be G90, minimum. Door finish shall be manufacturer's standard baked-on epoxy primer with polyester finish coating. Color shall be selected from Manufacturer's standard color range. Interior surface shall be painted galvanized steel.

Counterbalancing mechanism shall be torsion spring type. Rollers shall be case-hardened steel single rollers installed. Standard lift vertical and horizontal tracks.

Provide head and jamb weatherstripping.

2.2.02 Components. Tracks shall be manufacturer's standard galvanized steel racks and accessories designed to accommodate door size, width and clearances indicated from adjacent construction. Provide brackets and reinforcing for rigid support of roller guides, for door type and size. Fabricate vertical track sections with slots for door drop safety device at 2 inches (5.1 cm) on center. Tilt tracks from vertical to achieve closure at jambs when sectional door is closed. Weld or bolt to track supports. Support tracks with manufacturer's standard anchors and brackets for size and weight of door, to provide strength and rigidity, and smooth and continuous operation. Provide continuous angle anchored to wall and welded to track in accordance with manufacturer's instructions.

For overhead support, provide continuous angle welded to horizontal tracks and braced laterally to overhead structural members at each end of the tracks.

Counterbalancing Mechanisms shall be tempered steel torsion springs mounted on and secured to a hardened tubular steel shaft, with cable drums attached at each end of the shaft. Cable drums shall be grooved cast aluminum or gray iron castings, wrapped with cable attached to door. Counterbalance supports shall be one ball-bearing bracket at each end of shaft and at midpoint, for shafts up to 16 feet (4.9 m) long. Provide two additional brackets at third points to support shafts over 16 feet (4.9 m) long.

Emergency doorstop shall be Spring-loaded steel or bronze cam secured to bottom door rollers at each track. To cushion doorstop, provide spring bumper attached at end of each horizontal track.

2.2.03 ELECTRIC MOTOR AND CONTROLS. Electric door operators shall be manufacturer's standard electric operator sized as indicated, complete with gear reduction mechanism and control devices.

For emergency disconnect, provide mechanism to allow transfer to manual hand chain operation, with safety device to lock out use of motor when chain is in use.

Door operator type shall be trolley or drawbar type, V-belt and roller chain primary drive.

Electric motors shall be reversible constant duty, Class A insulated motor protected against overload; with capacity to move door at rate of 2/3 foot (162.6 cm) to 1 foot (30.5 cm) per second.

Provide open drip-proof type motor, complying with NEMA MG 1 and controller with enclosure of type indicated, complying with NEMA ICS 6.

Provide control stations of type indicated complete with enclosure complying with

NEMA ICS 6.

Provide remote door control panel, with open-close-stop function for each individual door.

Provide hand held remote control unit for each door, with different signal for each door.

Automatic reversing control shall be provided through automatic safety switch that complies with UL 325, installed within neoprene or rubber astragal located along full width of door bottom. Safety switch type shall be electric; where indicated. Weather Seals shall be continuous rubber, neoprene, or flexible vinyl adjustable weatherstrip gasket at head and jambs of overhead door, for weathertight installation.

Provide manufacturer's standard vision panels of materials indicated, located where shown on the drawings.

Install vision panels in metal framed doors with manufacturer's standard dry glazing gasket.

Glazing stops shall be removable; made from door section frame material.

2.2.04 Accessories. Hardware shall be heavy duty made from noncorrosive metal and provided with noncorrosive fasteners, as required for door type.

Provide heavy steel hinges at each end and intermediate stile, of type recommended by manufacturer for size of overhead door. Thru-bolt hinges to door sections at stiles and rails using lock washers and nuts, or rivets where access to nuts is not available.

Provide heavy duty ball-bearing rollers, in steel races. Mount rollers with projections from door surface as required to suit slop of track.

Roller tires shall be type indicated; 3 inch (7.6 cm) diameter tires for 3 inch (7.6 cm) track, 2 inch (5.1 cm) diameter tires for 2 inch (5.1 cm) track; track size as recommended by door manufacturer for required door size.

2.3 MANUFACTURER AND FABRICATION.

2.3.01 Steel Door Sections. Fabricate from galvanized steel sheet, maximum 24 inch (61.0 cm) high section, nominal 2 inches deep (5.1 cm), and in profile indicated on the drawings.

Provide 16 gage (1.6 mm) galvanized steel channel end closures, and intermediate 16 gage (1.6 mm) channel reinforcing at 48 inches (1.22 m) on center, maximum along interior surface of section.

Section reinforcing shall be continuous horizontal and diagonal steel reinforcing, as necessary to comply with wind loading performance criteria. Bottom section reinforcements shall be continuous channel or angle matching section profile.

2.3.02 Door Insulation. Shall be manufacturer's standard polyurethane foam insulation. Conceal insulation with manufacturer's standard interior steel facing sheet.

2.3.03 Steel Door Finishes. Clean zinc-coated steel and apply zinc phosphate conversion coat. Use factory paint system to apply prime and finish coats to interior and exterior surfaces of door faces.

2.3.04 Roll-up or Coiling Door. Construct doors of interlocking roll-formed galvanized steel sheet slats of 20 USS gage (1.0 mm) minimum thickness, unless otherwise specified, and nominal height of 2 5/8 inches (6.7 cm). Fit bottom of door with two steel angles back to back to make contact with floor when closed.

Fit ends of alternate slats with malleable iron end locks, acting to form wearing surface in the guide and prevent lateral movement of slats. Provide doors over 16 feet (4.9 m) in width with windlocks.

Minimum thickness of slats for doors wider than 19 feet, 6 inches (5.9 m) shall be18 USS gage (1.3 m).

Guide shall be steel structural shapes not less than 3/16 inch (4.8 mm) thick and of size to retain door in place under normal conditions, fitted at top into slots cast in mouth of roller shaft brackets.

Manufacturer roller shaft form steel pipe of size and weight to prevent deflection under weight of door in excess of 0.03 inch per foot (2.5 mm per meter) of span; fitted with machined cast iron plugs; and house oil-tempered helical spring counterbalancing mechanism capable of producing sufficient torque to assure easy operation of door at any position, with spring tension adjustable by means of wheel on outside of end bracket.

Brackets shall be cast iron or steel, designed to form an end closure and support for roller and hood; have bronze journal to receive shaft bearings; bracket hub and plug at the spring end of shaft fitted with self-lubricating bronze bearings or permanently lubricated seal ball bearings.

Hood shall be of 24 USS gage (0.7 mm) galvanized steel sheet, formed to fit contour of door coil and reinforced at top and bottom edges.

Design exterior doors to resist a wind pressure of 20 psf (97.6 kg/sq m), with an allowable fiber stress of 27,000 psi (186,165 kPa). Design bottom bar to withstand specified wind pressure without exceeding a deflection of 1/120 of the span.
For exterior doors, provide slats having a flat surface, tubular shaped and filled with insulation. Doors with insulated slats: of thickness to provide a "U" value of 0.2 Btu, hour, square feet, degree F or less.

For exterior doors, provide weatherstripping at jambs and neoprene astragal at bottom of door. Fit hoods for exterior doors with neoprene baffle at top of door barrel full width of door.

Construct fire doors in accordance with UL-approved specifications. Fit the ends of each slat with malleable iron end locks. Provide automatically released flame baffle to close space between hood and roller shaft. Furnish labels or certificates for each door as follows:

> If labeled fire door is indicated, furnish the UL classification marking for hourly rating and classification of wall opening indicated. Where labeled fire door exceeds 120 square feet of area (11.15 sq m) or a maximum dimension of 12 feet (3.7 m), furnish UL certificate of inspection.
>
> If non-labeled fire door is indicated, furnish manufacturer's certification that door has been constructed in accordance with UL approved specifications.

Equip fire doors with automatic closing mechanism designed to close door and release hood flame baffle if ambient temperature reaches 160 degrees F (71.1 degrees C), control closing speed to prevent injury to personnel and impact damage to door, to hold door in closed position until mechanism is reset, and not in any way affect operation of the door in general service.

Finish for door slats shall be chemically cleaned, bonderized and given a shop coat of baked on prime paint. For other surfaces of door parts apply a shop coat of prime paint.

2.3.05 <u>Operating Equipment for Power Operated Doors</u>. Power operator components shall comply with MFPA.

Provide totally enclosed, non-ventilated, instantly reversible, ball bearing motor in standard NEMA frame, manufactured by General Electric, Howell, Westinghouse, or as approved, design to operate on 480 volts, 3 phase, 60 hertz, alternating current, to be removable without affecting manual operation or limit switch setting, and to have sufficient capacity to operate door at speed of one foot per second without exceeding a temperature rise of 131 degrees F (55 degrees C) above 104 degrees F (40 degrees C) ambient, but not less than 1/2 hp.

Provide three-button push control for power operators. Momentary pressure on the “open” button shall cause the door to travel to the full open position, stop and remain open. Constant pressure on the “close” button causes the door to travel toward the closed position. When the door is in closing motion, it stops and immediately returns to the full open position if the safely edge switch is actuated before reaching the closed-position limit switch. The door stops upon release of the “close” button, or upon reaching the closed-position limit switch. Momentary pressure on the “stop” button stops the door in any position during opening.

2.3.06 Control Equipment. Power from the electrical system to control panels shall be provided as defined in Master Specifications Division 16, Electrical.

Provide all components, including conduit, interconnecting power and control wiring, control devices and control panels, necessary for a complete and operative installation, complying with NFPA 70.

Provide controls, which operate at a voltage not to exceed 120 volts. Provide necessary control transformer, with primary and secondary overcurrent protection, with control transformer secondary effectively grounded per NFPA 70.

Provide reduction gears that operate in oil bath in an enclosed gear box.

Friction clutch shall be set to allow only slightly more power to reach the operator than is required to operate the door, designed to slip free if door becomes stalled and adjusted to cushion the starting, stopping and reversing loads.

Solenoid brake shall prevent door from coasting and hold door locked when closed.

Provide power operated doors with auxiliary hand chain operation with a device to disconnect the door from power operation, release the brake and allow manual operation in case of power failure or if motor is removed from the operator.

Control door movement by a limit switch, easily adjustable to stop in any position and enclosed in a cast iron or steel box, General Electric CR115E or G, or as approved.

Equip bottom weatherstripping astragal running full width of door with a foil-safe type safety switch, consisting of a stainless steel contact plate and phosphor-bronze coiled contact spring. Provide coil cord connection as required.

Finish exposed ferrous metal parts of operating equipment with factory applied machinery enamel.

Design operators to be bracket mounted.

Enclose each control panel in a NEMA 12 enclosure. Provide items, transformers, fuse blocks, reversing starter, reversing relays, and other electrical equipment as an integral part of the control panel and so mounted as to enable easy replacement. Mount on the door of the control panel, the selector switch for automatic or manual operation.

Provide heavy-duty type; push button stations, NEMA 12 oiltight for indoor use and NEMA 4 weatherproof for outdoor use. Locate push button stations adjacent to door as indicated or as otherwise directed.

PART 3 - EXECUTION

3.1 INSPECTION. Examine openings to receive overhead doors for conditions that will prohibit proper installation. Correct unacceptable conditions before start of installation.

3.2 PREPARATION. Prepare surfaces at openings where sectional overhead doors will be installed in accordance with manufacturer’s recommendations.

3.3 INSTALLATION. Install complete overhead door assembly in compliance with manufacturer’s instructions.

Anchor vertical tracks to rough opening perimeter at minimum 24 inches (61.0 cm) on center.

Support horizontal tracks from overhead framing with welded or bolted steel angles or channels, including diagonal bracing as necessary for secure installation.

Anchor guides to steel door frame. Furnish anchor bolts and install them or supervise their installation.

3.4 FIELD QUALITY CONTROL.

3.4.01 Inspection. After door installation is complete, examine door performance, test operation, and adjust installation to provide smooth and quiet operation. Adjust door operators for proper performance in accordance with manufacturer’s instructions.

3.5 MAINTENANCE.

3.5.01 Protection. After installation and until final acceptance, protect door, equipment, and accessories from damage, and maintain in clean condition and operating properly.

3.5.02 Cleaning. Clean all door surfaces, tracks, springs, and operators, before final acceptance.

End of Section

SECTION 08342

FIBERGLASS DOORS AND FRAMES

PART 1 – GENERAL

1.1 SCOPE. This section includes fiberglass reinforced plastic doors, frames, and light openings.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM C 365 - Standard Test Method for Flatwise Compressive Strength of Sandwich Cores.

ASTM C 518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

ASTM D 256 - Test Methods for Impact Resistance of Plastics and Electrical Insulation Materials.

ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.

ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C.

ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

ASTM D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

ASTM D 1622 - Standard Test Method for Apparent Density of Rigid Cellular Plastics.

ASTM D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

ASTM E 152 - Standard Methods of Fire Tests of Door Assemblies.

SDI 107 - Hardware on Steel Doors (Reinforcement - Application).

SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames.

Certification Listings; Warnock Hersey.

1.3 SUBMITTALS. Submit in accordance with Section 01300.

1.3.01 Product Data.

Manufacturer's installation instructions.

Manufacturer's care and maintenance instructions.

Color charts for selection of door colors.

1.3.02 Shop Drawings. Dimensions, elevations, assembly methods, hardware reinforcement locations and preparations, wall conditions, and opening identification.

1.3.03 Samples. Submit samples representing specific construction of doors and frames required for this project.

Doors: Show stiles, core, and fiberglass-encapsulated reinforcements.

Frame: Show profile with corner joint, core, and fiberglass-encapsulated reinforcements.

1.3.04 Calculations. Submit calculations for fiberglass composite door, verifying theoretical limits of thermal warpage based upon the exposure temperature differential.

1.4 DELIVERY, STORAGE, AND HANDLING. Deliver, store, and handle doors and frames with care to prevent damage and deformation.

Identify doors and frames with the manufacturers name tag, location, door type, color, and weight.

Inspect doors and frames upon delivery for damage. Minor damage may be repaired provided refinished items are equal in all respects to new Work, and are acceptable to the Architect. Otherwise remove and replace damaged items as directed.

Store on pallets in the original carton at the job site.

1.5 WARRANTY. The manufacturer shall warrant the fiberglass reinforced plastic doors and frames:

From failure due to workmanship and materials for 5 years from date of installation.

Against corrosion failure caused by the environment specified for 10 years from date of installation.

From thermal warpage as determined by the theoretical limits for a structurally steel reinforced fiberglass composite door.

This guarantee shall not extend to failure caused by physical abuse and shall not cover costs for dismounting or reinstallation, labor, crating, or freight.

PART 2 – PRODUCTS

2.1 MANUFACTURER. Subject to compliance with requirements, provide products by one of the following:

Fenestra

Warminster Fiberglass Company

Chemproof

Or Approved Equal

2.2 FIBERGLASS DOORS. Produce doors seamlessly by molding in place all mortises, openings, recesses, pockets, and steel encapsulated reinforcements to receive finish hardware, including drilling and tapping, in accordance with finish hardware schedule and templates provided by hardware supplier.

2.2.01 Fiberglass Reinforced Plastic Doors. Thickness: 1-3/4 inches.

Height, width, and other features as indicated.

Resin transfer molded in matched metal molds to produce industrial quality doors which have a smooth finish.

Mold in one piece creating a seamless monolithic composite consisting of gel-coat, fiberglass reinforcement, polyester resin, insulating core, and internal reinforcements.

2.2.02 Exterior Surface. Gel-coat with a smooth low luster finish free from fiber pattern, roughness, or other irregularities.

Gel-coat thickness: 0.025 inch.

Resistant to moisture and ultraviolet degradation.

F.D.A. approved Gel coat.

2.2.03 Exterior Laminate. Chemically bonded with gel-coat; minimum 1/8 inch thick.

Composition: Halogenated polyester resin and continuous strand fiberglass reinforcement; minimum glass content of 25%.

Fire retardant rating (ASTM E 84): Class I.

2.2.04 Core. 1-1/2 inch thick; minimum insulating value of R-11.5.

Rigid closed cell, self-extinguishing polyisocyanurate foam; density of 1.9 pounds per cubic foot.

Perforated to form resin posts during the molding process which tie the exterior laminates together.

2.2.05 Internal Reinforcements. Provide reinforcements to SDI 107 thickness standards, and block-outs as required by templates for hardware specified in hardware section.

Combination of 1-9/16 inch thick structural end grain Balsa core, 1/8 inch thick steel flats, and 1/8 inch thick fiberglass ribs and 2 pieces of steel tubing, 1-1/2 inch x 1 inch x 14 gage by door height.

Incorporate reinforcements into the doors during the resin transfer molding process.

Provide structural Balsa core on latch side.

Provide structural Balsa core with steel flats where high stress loads are induced by surface applied hardware such as closers and surface bolts.

Provide a continuous steel flat on the hinge side for optimum screw retention for mortised or continuous hinges.

Provide vertical fiberglass rib reinforcements surrounding steel tubing stiles 6 inches from the door sides to structurally rigidize the door and limit thermal warpage to theoretically determined tolerances for specified door size. The vertical reinforcing ribs and tubing will leave an insignificant shrink line the full length on both sides of the door, which is acceptable.

2.3 FIBERGLASS FRAMES. Produce frame, jambs, and head seamlessly by molding in place all mortises, openings, recesses, pockets, and steel encapsulated reinforcements to receive finish hardware, including drilling and tapping, in accordance with finish hardware schedule and templates provided by hardware supplier.

2.3.01 Fiberglass Reinforced Plastic Frames.

5-3/4 inch jamb with a 2 inch face, 5/8 inch stop and 5/8 inch return.

Resin transfer molded in matched metal molds to produce a knocked down profile with a smooth finish.

Monolithic composite consisting of gel-coat, fiberglass reinforced laminate, structural end grain Balsa core, and internal reinforcement.

Provide mitered corners and molded pockets for corner reinforcement.

Head profile with molded corner tabs for head to jamb alignment during assembly.

During the molding process, mold in place mortises, recesses, and openings to produce a totally seamless profile.

2.3.02 Exterior Gel Coat Surface. Match gel coat of doors.

2.3.03 Exterior Laminate: Chemically bonded with gel-coat; minimum 1/8 inch thick.

Composition: Halogenated polyester resin and continuous strand fiberglass reinforcement; minimum glass content of 25%.

Fire retardant rating: Class I.

2.3.04 Structural Core. Provide ½ inch thick end grain Balsa core with a density of 8 pounds per cubic foot.

Core porosity to allow resin to penetrate the surface during molding and to develop a high strength bond between the core and laminate.

2.3.05 Internal Reinforcements. Provide reinforcements to SDI 107 gage thickness standards, and block-outs as required by templates for hardware specified in hardware section.

1/8 inch thick steel flats, totally encapsulated in the fiberglass laminate.

Incorporate steel reinforcement into the frame profile during the resin transfer molding process.

Encapsulate a continuous steel flat in the hinge side jamb profile for optimum screw retention for mortise or continuous hinges.

Reinforce head profile with steel flats located in the face and stop for surface applied hardware.

Corner reinforcement: Steel angle 0.094 inch thick x 1-1/2 inch wide x 3-1/2 inch long which slips into molded corner pockets to ensure accurate location and prevent corner separation.

2.4 Transoms and Lights. Provide transom panels where indicated.

Provide borrowed lights where indicated.

Provide side lights where indicated.

2.5 Color Selection. The selected color shall pigment both the gel-coat and exterior laminate.

Color as selected by the Architect from the manufacturer's color chart.

2.6 ANCHORS. Provide jamb anchors within 18 inches of top and bottom each frame and at 24 inches on center in between, unless otherwise required for fire-rated frames.

New Masonry: Butt mounting jamb anchors, 18 gauge flat "T" anchors to suit frame size with legs a minimum of 1 inch x 6 inch.

2.7 SOURCE QUALITY CONTROL. The manufacturer shall maintain a continuous quality control program, and upon request shall furnish to the Architect certified test results of physical properties.

Minimum physical properties of the laminate:

Tensile Strength (ASTM D 638): 9,000 PSI.

Flexural Strength (ASTM D 790): 20,000 PSI.

Barcol Hardness (ASTM D 2583): 40 Min. Average.

Impact Resistance (ASTM D 256): 12 ft-lbs/inch.

Heat Distortion Point (ASTM D 384): 175 F.

Density/Specific Gravity (ASTM D 792): 93.6 PCF/1.5.

Burning Characteristics (ASTM E 84): Flame Spread, less than 25; Smoke Density, less than 200.

Thermal Expansion (ASTM D 696): 8 x 10-6 in/in degree F.

Minimum physical properties of the urethane foam core:

Thermal Conductivity (ASTM C 518): 0.13.

Density/Specific Gravity (ASTM D 1622): 1.9 PCF/.03.

Burning Characteristics (ASTM E 84): Flame spread, less than 35; smoke density, less than 240.

Minimum physical properties of end grain Balsa core:

Thermal Conductivity (ASTM C 518): 0.45.

Density/Specific Gravity (ASTM D 1622): 9-1/2 PCF/.128.

Compressive Strength (ASTM C 365): 1870 PSI. E. Prepare tests in accordance with ASTM D 618.

PART 3 - EXECUTION

3.1 FRAME INSTALLATION. Install frames plumb, level, square, and rigidly secured in the opening.

Use field applied bottom and center spreader to maintain opening dimensions.

Fabricate spreader from lumber at least 1 inch thick and approximately as wide as frame depth.

Cut clearance notches for frame stops.

Install anchors in appropriate positions; type as indicated by construction.

After frame is installed and secure, remove spreaders, leaving surfaces smooth and undamaged.

3.2 Door Installation. Install doors plum, level, and square.

Apply hardware and adjust to achieve quiet and smooth operation.

Adjust doors to fit snugly and close without sticking or binding.

Maximum clearances:

1/8 inch at jambs and heads.

1/4 inch at meeting stiles of pairs of doors.

1/4 inch between door bottom and finished floor or threshold.

3.3 Cleaning and Protection. Wrap doors and frames after installation and keep free of paint, plaster, cement, scratches, etc.

Leave Project site clean and free of debris.

End of Section

SECTION 08410

ALUMINUM ENTRANCES AND STOREFRONTS

PART 1 – GENERAL

1.1 SCOPE. This section covers exterior aluminum entrance doors and frames, interior aluminum vestibule doors and frames, storefront framing systems, and incidental services and accessories related to completion of this work.

1.2 GENERAL.

1.2.01 Governing Standards. Products furnished under this section shall comply with the applicable requirements of the following:

ASTM (American Society of Testing and Materials) B221 – Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes and Tubes

ASTM E283 – Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

ASTM E330 – Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference

ASTM E331 – Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Differences

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer's Qualifications. Provide entrances and storefronts produced by a single manufacturer with not less than 5 years of documented experience in the fabrication of assemblies of the type and quality required.

1.3.02 Contractors Qualifications. Entrances and storefronts shall be installed by a firm that has not less than 5 years of documented experience in the installation of systems similar to those required.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit manufacturer product specifications, technical product data, standard details, and installation recommendations for each type of entrance and storefront product required. Include information on fabrication methods, finishing, hardware, and accessories.

Submit shop drawings for fabrication and installation of entrances and storefronts, including elevations, detail sections of typical composite members, hardware, mounting heights, anchorages and reinforcements, expansion provisions, and glazing details.

1.4.02 Certification. Provide certified test results showing that entrance and storefront systems have been tested by a recognized testing laboratory or agency and comply with specified performance characteristics.

1.4.03 Samples. Submit 2 samples of each type and color of aluminum finish, on 12 inch (30.5 cm) long sections of extrusions or formed shapes and on 6 inch (15.2 cm) square sheets. Where color or texture variations are anticipated, include 2 or more units in each set of samples indicating extreme limits of variations.

1.5 WARRANTY. Submit a written warranty, executed by the Contractor, Installer and Manufacturer, agreeing to repair or replace units (including reglazing) which fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to, structural failures including excessive deflection, excessive leakage or air infiltration, faulty operation, and deterioration of metals, metal finishes and other materials beyond normal weathering. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.

Warranty period for aluminum entrances and storefronts is 5 years from the date of substantial completion.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS.

2.1.01 Field Measurements. Check openings by field measurement before fabrication to ensure proper fitting of work; show measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay in the work. Where necessary, proceed with fabrication without field measurements, and coordinate fabrication tolerances to ensure proper fit.

2.2 PERFORMANCE AND BASIS OF DESIGN. Drawings indicate typical sizes, spacings of members, profiles and dimensional requirements of entrance and storefront Work. Minor deviations will be accepted in order to utilize manufacturer standard products when, in the Engineer's judgment, such deviations do not materially detract from the design concept intended performances.

2.2.01 Performance Requirements. Provide aluminum entrance and storefront assemblies that comply with specified performance characteristics. Each system shall be tested by a recognized testing laboratory or agency in accordance with specified test methods. Provide certified test results.

2.2.02 Thermal Movement. Provide systems capable of withstanding thermal movements resulting from an ambient temperature range of 120 deg. F (48.9 deg. C), that could cause a metal surface temperature range of 180 deg. F (82.2 deg. C) within the framing system.

2.2.03 Wind Loading. Provide assemblies capable of withstanding a uniform pressure of 25 psf (122.0 kg/sq m) inward and 25 psf (122.0 kg/sq m) outward when tested in accordance with ASTM E 330, with deflection not to exceed 1/240.

2.2.04 Fixed Framing Transmission Characteristics. Provide aluminum entrance and storefront framing system that complies with requirements indicated for transmission characteristics.

2.2.05 Air Infiltration. Provide framing system with an air infiltration rate of not more than 0.06 cfm per sq. ft. (1.83 cu cm per sq cm) of fixed area (excluding operable door edges) when tested in accordance with ASTM E 283 at an inward test pressure differential of 6.24 psf (0.04 kg/sq m).

2.2.06 Water Penetration. Provide framing systems with no water penetration (excluding operable door edges) as defined in the test method when tested in accordance with ASTM E 331 at an inward test pressure differential of 6.24 lbf per sq ft (0.40 kg/sq m).

2.2.07 Condensation Resistance. All framing systems shall be "thermal-break" construction, with units tested for thermal performance in accordance with AAMA 1502 showing condensation resistance factor (CRF) of not less than 45.

2.2.08 Thermal Transmittance. Provide framing systems that have an overall U-value of not more than 0.65 BTU/(hr. x sq. ft. x deg. F) at 15 mph (24.1 kph) exterior wind velocity when tested in accordance with AAMA 1503.

2.2.09 Weep System. Provide system for positive drainage to exterior.

2.3 ACCEPTABLE MANUFACTURERS.

2.3.01 Frames and Stile and Rail Doors. Subject to compliance with requirements, provide products from Kawneer Company, Inc., PPG Industries, Inc., Tubelite Div., Indal Inc., Amarlite Engineerural Products, or others as approved.

2.4 MATERIALS.

2.4.01 Aluminum Members. Provide alloy and temper recommended by the manufacturer for strength, corrosion resistance, and application of required finish; comply with ASTM B 221 for extrusions and ASTM B 209 for sheet or plate.

2.4.02 Fasteners. Provide fasteners of aluminum, nonmagnetic stainless steel, or other materials warranted by the manufacturer to be noncorrosive and compatible with aluminum components, hardware, anchors and other components.

2.4.03 Reinforcement. Where fasteners screw-anchor into aluminum less than 0.125 inches (3.2 mm) thick, reinforce the interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard noncorrosive pressed-in splined grommet nuts.

2.4.04 Exposed Fasteners. Except where unavoidable for application of hardware, do not use exposed fasteners. For the application of hardware, use fasteners that match the finish of member or hardware being fastened. Provide Phillips flat-head machine screws for exposed fasteners.

2.4.05 Concealed Flashing. Provide 26 gage (0.55 mm) minimum dead-soft stainless steel, or 0.026 inch (0.66 mm) minimum extruded aluminum of alloy and type selected by manufacturer for compatibility with other components.

2.4.06 Brackets and Reinforcements. Where feasible, provide high-strength aluminum brackets and reinforcements; otherwise provide nonmagnetic stainless steel or hot-dip galvanized steel complying with ASTM A 386.

2.4.07 Concrete/Masonry Inserts. Provide concrete and masonry inserts fabricated from cast-iron, malleable iron, or hot-dip galvanized steel complying with ASTM A 386.

2.4.08 Compression Weatherstripping. Provide the manufacturer's standard replaceable compressible weatherstripping gaskets of molded neoprene complying with ASTM D 2000 or molded PVC complying with ASTM D 2287.

2.4.09 Sliding Weatherstripping. Provide the manufacturer's standard replaceable weatherstripping of wool, polypropylene, or nylon woven pile, with nylon fabric or aluminum strip backing, complying with AAMA 701.2.

2.4.10 Glass and Glazing Materials. Glass and glazing materials shall comply with requirements of Master Specification Section 08800, Glazing.

2.5 CONSTRUCTION. Sizes of door and frame units, and profile requirements, are indicated on drawings. Nominal dimensions are indicated, to achieve design requirements and co-ordination with other work. Significant variations shall be subject to approval.

2.5.01 Thermal-Break Construction. Fabricate storefront framing system with integrally concealed, low conductance thermal barrier, located between exterior materials and exposed interior members to eliminate direct metal-to-metal contact. Use manufacturer's standard construction that has been in use for similar projects for period of not less than 3 years.

2.5.02 Aluminum Door Frames. Fabricate tubular and channel frame assemblies, as indicated, with welded or mechanical joints in accordance with manufacturer's standards; reinforce as necessary to support required loads.

2.5.03 Stile and Rail Type Aluminum Doors. Provide tubular frame members, fabricated with mechanical joints using heavy inserted reinforcing plates and concealed tie-rods or j-bolts. Provide 1-3/4 inch (4.4 cm) thick doors of design indicated. Door stile and rail sections to be a minimum.125 inch (3.2 mm) wall thickness. Wide stile should have minimum 5 inches (12.7 cm) width. Overall width of top rail to be a minimum of 5 inches (12.7 cm). Overall width of bottom rail to be a minimum of 12 inches (30.5 cm).

Fabricate doors to facilitate replacement glass or panels, without disassembly of stiles or rails. Provide snap-on extruded aluminum glazing stops, with exterior stops anchored for non-removal.

2.6 MANUFACTURE AND FABRICATION.

2.6.01 Prefabrication. Before shipment to the project site, complete fabrication, assembly, finishing, hardware application, and other work to the greatest practicable extent. Disassemble components only as necessary for shipment and installation.

Preglaze door and frame units to greatest practicable extent at contractor option.

Do not drill and tap for surface-mounted hardware items until time of installation at project site. Coordinate with hardware supplier.

Perform fabrication operations, including cutting, fitting, forming, drilling and grinding of metal work to prevent damage to exposed finish surfaces. For hardware, perform these operations prior to application of finishes.

2.6.02 Welding. Comply with AWS recommendations; grind exposed welds smooth and restore mechanical finish.

2.6.03 Reinforcing. Install reinforcing as required for hardware and necessary for performance requirements, sag resistance and rigidity.

2.6.04 Dissimilar Metals. Separate dissimilar metals with zinc chromate primer, bituminous paint, or other separator that will prevent corrosion.

2.6.05 Continuity. Maintain accurate relation of planes and angles, with hairline fit of contacting members.

2.6.06 Uniformity of Finish. Abutting extruded aluminum members shall not have an integral color or texture variation greater than half the range indicated in the sample pair submittal.

2.6.07 Fasteners. Conceal fasteners wherever possible.

2.6.08 Weatherstripping. For exterior doors, provide compression weatherstripping against fixed stops; at other edges, provide sliding weatherstripping retained in adjustable strip mortised into door edge.

Provide EPDM or vinyl blade gasket weatherstripping in bottom door rail, adjustable for contact with threshold.

At interior doors and other locations without weatherstripping, provide neoprene silencers on stops to prevent metal-to-metal contact.

2.6.09 Natural Anodized Finish. Provide NAAMM Class 1 (non-specular as fabricated mechanical finish; chemical etch, medium matte; minimum thickness 0.7 mil (0.18 mm)) anodic coating, Clear AA-M12C22A41.

2.6.10 Hardware. Refer to Master Specification Section 08710, Finish Hardware for requirements for hardware items other than those indicated to be provided by the aluminum entrance manufacturer.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Comply with manufacturer instructions and recommendations for installation, unless higher standards are required.

Set units plumb, level, and true to line, without warp or rack of framing members, doors, or panels. Provide proper support and anchor securely in place.

Separate aluminum and other corrodible metal surfaces from sources of corrosion due to electrolytic action at points of contact with other materials. Comply with requirements specified under paragraph "Dissimilar Materials" in the Appendix to AAMA 101-85.

Drill and tap frames and doors and apply surface-mounted hardware items. Comply with hardware manufacturer's instructions and template requirements. Use concealed fasteners wherever possible.

Set sill members and other members in bed of sealant as indicated, or with joint fillers or gaskets as indicated to provide weathertight construction.

3.1.02 Final Adjustments. Adjust operating hardware to function properly, for smooth operation without binding, and for weathertight closure.

3.1.03 Cleaning. Clean the completed system inside and out, promptly after installation, exercising care to avoid damage to coatings.

Clean glass surfaces after installation, complying with requirements contained in Master Specification Section 08800, Glass and Glazing for cleaning and maintenance. Remove excess glazing and sealant compounds, dirt and other substances from aluminum surfaces.

3.1.04 Protection. Institute protective measures required throughout the remainder of the construction period to ensure that aluminum entrances and storefronts will be without damage or deterioration, other than normal weathering, at time of acceptance.

3.2 MAINTENANCE. Submit manufacturer’s Maintenance Instructions for each type of system required.

End of Section

SECTION 08520

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SCOPE. This section covers fixed type, stick-framed aluminum windows complete with all necessary hardware, anchors, accessories, and miscellaneous equipment as specified and indicated.

1.2 GENERAL.

1.2.01 Governing Standards.

AWS (American Welding Society) A.5.3-62 - Aluminum and Aluminum-Alloy Arc Welding Electrodes.

ASTM (American Society of Testing and Materials) A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

ASTM B221 - Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Wire, Profile, and Tube.

ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM C509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.

ASTM E283 - Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

ASTM E330 - Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

ASTM E331 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

FS (Federal Specifications) TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid-Resistant.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturers Qualifications. Manufacturers shall have not less than five years documented experience in manufacture of aluminum windows of the type specified.

1.3.02 Contractors Qualifications. Erector shall have not less than five years documented experience in the installation of aluminum windows of the type specified.

1.3.03 Tolerances. Dimensions shall be within ±1/16 inch (1.6 mm).

Air infiltration test shall be conducted per ASTM E283 with a maximum infiltration of 0.06 cfm per square foot (1.83 cu cm per sq cm).

Water penetration test shall be conducted per ASTM E331 with no water penetration for 15 minutes when window is subjected to rate of flow of 5 gal/hr/sq ft (244.71/hr/sq m) with differential pressure across the window unit of 6.24 psf (30.5 kg/sq m).

Wind load test shall be conducted per ASTM E330 using a minimum 60 psf (292.9 k/sq m) positive and negative load for 10 sec. with a maximum deformation of frame member 1/175 of span length and no damage to fasteners or hardware.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Shop drawings are required to show construction of all parts, metal thicknesses, installation and erection details including connections, anchorage, fastening, and sealing methods. Also show sections of typical members, dimensioned elevations, frame sizes, spacing of anchors and fasteners, and details of accessories.

Provide manufacturer’s color chart showing interior and exterior surface colors and manufacturer's recommended Installation and Maintenance Procedures.

1.4.02 Test Reports. Provide reports of source quality control tests.

1.5 DELIVERY, STORAGE, AND HANDLING. Handle windows carefully during transportation and at the job site. Store windows upright on pieces of lumber in a dry, covered location.

1.6 WARRANTY. Provide 5 year manufacturer warranty for insulated glass units from seal failure, interpane dusting or misting, and replacement of same. Warranty shall include coverage for degradation of color finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide "Isoglaze 45OT" Windows by Kawneer Company, Inc., Norcross, GA; or approved equal by Alumiline/Aldora, Lincoln, RI; Amarlite Corp., GA; PPG Industries, Inc., Pittsburgh, PA; Wausau Metals Corp., Wausau, WI; “3900 Series Windows by EFCO”.

2.2 MATERIALS. Screws, bolts, washers, nuts, rivets, and other fastening devices shall be aluminum, nonmagnetic stainless steel or other noncorrosive materials compatible with aluminum.

Horizontal Mullions shall be extruded aluminum members similar in size and shape to perimeter framing and designed to withstand uniform wind pressure of 20 psi (137.9 kPa) without deflection more than 1/175 of mullion span.

Aluminum extrusions shall comply with ASTM B221 and be Alloy 6063 with Temper T-5.

Provide one piece aluminum framed screens with aluminum or fiberglass screen cloth for each operating window.

Fasteners and hardware shall be Manufacturer's Standard non-corrosive.

Provide protective coatings. For bituminous coating compound, use SSPC-Paint 12 (cold-applied asphalt mastic). For Zinc Chromate Primer, use FS TT-P-645. For sealant compounds, use FS TT-S-00230.

2.3 MANUFACTURE AND FABRICATION. Fabricate framing of extruded aluminum sections to enable outside glazing with snap-on outside trim, provide thermal breaks; weep leakage to exterior; glass set back maximum of 3/4 inches (1.9 cm) from outer face; framing depth 4-1/2 inches (4.4 cm) maximum; jamb, head and horizontal mullion frames 1-3/4 inches (5.7 cm) minimum and 2 1/4 inches (11.4 cm) maximum Widths; and completely without exposed fastenings.

2.3.01 Mechanical Assemblies. Fit corner joints rigid and weather tight. Fasteners shall be concealed when window is installed and closed. Join frame members by mechanical means.

2.3.02 Sills. Furnish in full length, for single windows in single openings.

2.3.03 Mullions. Provide horizontal mullions between multiple window units. Fasten to adjacent window units. Permit expansion and contraction. Form watertight joints.

Provide extruded aluminum trim angles where indicated at interior face of windows. Finish to match windows, including flat head screw fastenings.

2.3.04 Shop Painting. Provide spray-applied, medium gloss finish applied during manufacture for exposed aluminum surfaces in accordance with AAMA 605.2, equal to PPG industries, Inc. “Duranar” – a 2 coat, factory-applied fluropolymer coating system based on Elf Atochem North America, Inc. “Kynar 500” or Ausimont USA, Inc. “Hylar 5000” polyvinylidene fluoride (PVF2) resin, with a minimum dry film thickness of 1.2 mils (0.03 mm).

Employ an applicator licensed by coating system manufacturer to apply the finish in accordance with manufacturer’s specifications for application and quality control.

Insulate aluminum which will come in contact with concrete, masonry wood, or dissimilar metals (except stainless steel, white bronze, or solid zinc) by application of heavy brush coat of alkali resistant bituminous paint.

Clean and remove scratches and tool marks from exposed surfaces.

Ensure that aluminum surfaces are free from blemishes and defects.

PART 3 - EXECUTION

3.1 INSTALLATION. Install fastenings, clips, anchors, and other appurtenances.

3.1.01 Application. Install and adjust windows in accordance with the manufacturer's accepted shop and erection drawings.

Install windows plumb, square, level, and in the correct horizontal and vertical alignment, in prepared openings without forcing.

Anchor windows, as indicated or accepted, with aluminum, nonmagnetic stainless steel, or other noncorrosive materials compatible with aluminum.

Set metal-to-metal joints between members of window frames and mullions, and mullion coverplates in a mastic sealant of a type recommended by the window manufacturer to provide completely weather tight joints. Remove excess mastic before it hardens.

3.1.02 Protection. After installation, protect windows from damage during subsequent construction activities.

3.1.03 Cleaning. Clean mortar, paint and other foreign matter from both the inside and outside metal surfaces of the windows in accordance with window manufacturer's' recommendations.

End of Section

SECTION 08710

FINISH HARDWARE

PART 1 - GENERAL

1.1 SCOPE. Furnish, install and adjust finishing hardware, as scheduled under the enclosed list of hardware sets.

1.2 GENERAL.

1.2.01 Coordination. Prior to development of the Hardware Schedule, arrange a Finish Hardware Meeting to be attended by the Engineer and the hardware supplier's personnel directly responsible for preparing the Hardware Schedule. Attendance at this meeting is mandatory.

The purpose of the meeting is to review the hardware schedule requirements identified in the Contract Documents. The participants shall review the specification requirements for the hardware schedule, formats, hardware locations, opening descriptions, products specified versus products proposed, and other information specified.

The Engineer shall approve the format and content of the hardware schedule. Before the installation of finish hardware begins, a hardware installation seminar for the installation of door closers, and exit devices, and locksets shall be conducted by the manufacturer's representative of these products. The seminar to be held at job site and attended by all installers of hardware. Examples include aluminum doors and carpentry installers. Seminar shall address proper coordination and installation of exit devices, door closers, and weatherstripping, as detailed in the finish hardware schedule for this Project, with the use of installation manuals, hardware schedule, templates, physical product samples, and exit device installation videos.

1.2.02 Governing Standards.

ANSI (American National Standards) A 156.1 - Butts and Hinges.

ANSI A 156.2 - Locks and Lock Trim.

ANSI A 156.3 - Exit Devices.

ANSI A 15-6.4 - Door Controls (Closers).

ANSI A 156.5 - Auxiliary Locks and Associated Products.

ANSI A 156.6 - Architectural Door Trim.

ANSI A 156.7 - Template Hinges.

ANSI A 156.8 - Door Controls (Overhead Holders).

BHMA (Builders Hardware Manufacturers Association) 1301, Material and Finishes Standard.

1.3 QUALITY ASSURANCE.

1.3.01 Supplier's Qualifications. An established finish hardware supplier who is a factory authorized distributor for supplier shall be all products required, and has display samples, inventory, and qualified personnel trained and experienced in preparing Hardware Schedules, issuing templates, and ordering, furnishing, and servicing hardware for architecturally designed projects. Supplier shall employ an experienced Architectural Hardware Consultant who is available to Engineer, at reasonable times during the course of the Work, for consultation about the Project's hardware requirements.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit for review complete hardware schedule, giving illustrations, descriptive data, manufacturer's specifications.

Furnish complete hardware location diagrams and templates to the door and frame manufacturer's and other suppliers of work requiring hardware. Ensure accurate location, coordination and proper installation of finishing hardware.

Submit elevation and wiring drawings for electrical and pneumatic hardware showing relationship of all electrical and pneumatic hardware components to door and frame. Indicate number and gage of wires required. Indicate size of air tubing required. Indicate psi requirements or wiring drawing showing point to point wire hook up and air tubing for all components. Submit system operations descriptions for each type of opening and describe each possible condition.

Submit product data concurrently with hardware schedule, in booklet form, using supplier's schedule covers as binders, Product Data of items of hardware listed in supplier's schedule that are other than those specified. Identify in cover letter, stating changes and reasons.

1.4.02 Samples. Provide samples when requested by the Engineer. If samples are requested for proposed substitution, submit both specified hardware and proposed substitution samples.

1.4.03 Test Reports. Submit inspection report specified for closers.

1.5 DELIVERY, STORAGE AND HANDLING. Provide packages or containers having labels, identifying each hardware set according to acceptable sets listed.

1.6 WARRANTY. Closers shall have furnished manufacturer's 10-year warranty against manufacturing defects and workmanship.

Exit devices shall have furnished manufacturer's 3-year warranty against manufacturing defects and workmanship.

Replace defective work during warranty period to include but not limited to materials, labor and other costs incidental to the Work. Inspect the Work within 24 hours after receipt of notice from the Engineer. Replace Work found to be defective as defined in the Contract Documents.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.1.01 Regulatory Requirements. Furnish finish hardware that complies with the requirements of laws, codes, ordinances and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.

Furnish finish hardware to comply with the requirements of the regulations for the public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.

2.1.02 Fire-Rated Openings. Provide hardware for fire-rated openings in compliance with NFPA 80 and local building code requirements. Provide only hardware which has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

Emergency exit devices are to include but not limited to “Fire Exit Hardware” required on doors in compliance with applicable codes. Provide UL label on exit devices indicating "Fire Exit Hardware".

2.2 ACCEPTABLE MANUFACTURERS. Requirements for design, grade, function, finish, size and other distinctive qualities of each type of finish hardware shall be provided indicated in Hardware Schedule at the end of this section.

2.2.01 Hinges. Acceptable manufacturers include Hager, Lawrence McKinney, Stanley, or equal.

2.2.02 Locksets. Acceptable manufacturers include Corbin-Russwin, Yale, Sargent, or equal.

Provide Best Peaks Patented cores by Stanley Security Solutions, Inc.

2.2.03 Cylinders. The only acceptable manufacturer is Best (No Substitutions).

2.2.04 Kickplates. Acceptable manufacturers include Baldwin, Burns, Rockwood, or equal.

2.2.05 Flush Bolts & Coordinator. Acceptable manufacturers include Glynn-Johnson, Ives, or equal.

2.2.06 Closers. Acceptable manufacturers include LCN, Norton, or equal.

2.2.07 Bumpers & Holders. Acceptable manufacturers include Glynn-Johnson, Ives, or equal.

2.2.08 Thresholds & Weatherstripping. Acceptable manufacturers include Reese Zero, Pemko, National Guard, or equal.

2.2.09 Panic Hardware. Acceptable manufacturer include Von Duprin, Locknetics, IR dor-OMatic, Monarch.

Contractor must certify to Engineer that all Locksets, exit devices, and security devices are compatible. If such certification is impossible, Contractor must notify Engineer immediately of areas of incompatibility. If certification is not made before receipt of bids, all subsequent changes in locksets, exit devices, and security devices resulting from incompatibility will be made at the expense of the Contractor.

2.3 MATERIALS.

2.3.01 Hinges, Butts, and Pivots. Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

Furnish Phillips flat-head or machine screws for installation of units, except furnish Phillips flat-head or wood screws for installation of units into wood. Finish screw heads to match surface of hinges or pivots.

Except as otherwise indicated, provide non-removable stainless steel hinge pins. Provide number of hinges indicated but not less than 3 hinges for door leaf for doors 90 inches (228.6 cm) or less in height and one additional hinge for each 30 inches (76.2 cm) of additional height.

2.3.02 Lock Cylinders and Keying. Supplier will meet with Contractor to finalize keying requirements and obtain final instructions in writing.

All-locks shall be provided with approved cylinders and construction cores. At the completion of construction, construction cores shall be removed and final 6 pin cores keyed to the Owner's existing master system shall be provided by the Contractor. A minimum of 3 keys (or equivalent within the master system) shall be provided for each cylinder.

Construct lock cylinder parts from brass/bronze, stainless steel or nickel silver.

Permanently inscribe each key with number or lock that identifies cylinder manufacturer key symbol, and notation "DO NOT DUPLICATE". Provide keys of nickel or silver only.

The control (core) key for the new locks shall be given to DWSD mechanical maintenance."

2.3.03 Locks, Latches, and Bolts. Provide manufacturer's standard wrought box strike for each latch or lock bolt. Provide curved lip extended to protect frame and finished to match hardware set.

2.3.04 Closers and Door Control Devices. Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit, based size of door and anticipated frequency of use.

Furnish regular or parallel arm as required to mount closers on side of doors away from primary circulation space (lobby, corridor, or open area).

2.3.05 Miscellaneous. Provide manufacturer's standard exposed fasteners for door trim units (kickplates, edge trim and similar units); either machine screws or self-tapping screws.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Hand of Door. Drawings show direction of slide, swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.

2.4.02 Base Metals. Produce hardware units of base metal and forming method indicated. Use manufacturer's standard metal alloy, composition, temper and hardness, but no case of lesser (commercially recognized) quality than specified for the applicable hardware units by applicable ANSI A156 series standard for each type hardware item indicated. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.

2.4.03 Fasteners. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.

Furnish screws for installation, with each hardware item. Provide Phillips flathead screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of such other work as closely as possible, including "prepared for paint" in surfaces to receive painted finish.

2.4.04 Finish. Hardware Finish US26D, (BHMA626) unless otherwise indicated. At hinge butts, provide US26D plating over stainless steel. Spray finish cases of surface-applied closers to match metal finishes.

2.5 HARDWARE SETS. *Note: Below are some typical sets of hardware for typical situations. Please note that each design will require a specific list of hardware sets tailored to the exact doors included in the project. Additionally, the manufacturers and part numbers are changing continuously and will need to be provided by the designer at the time of design.*

Set No. 1 – *Single interior door with emergency egress, possibly in corridor*

1 1/2 pr Butts
1 Exit Device
1 Cylinder
1 Closer
1 Wall Bumper

Set No. 2 – *Single interior door, locking with closer, possibly to office area*

1 1/2 Pr Butts
1 Lockset
1 Cylinder
1 Closer
1 Wall Bumper

Set No. 3 – *Single non-locking interior door, possibly to bathroom or closet*

1 1/2 Pr Butts
1 Latchset
1 Closer
1 Kickplate
1 Wall Bumper

Set No. 4 – *Single exterior door without emergency egress equipment*

1 1/2 pr Butts
1 Lockset
1 Cylinder
1 Wall Bumper
1 Threshold
1 Weatherstrip Set

Set No. 5 – *Interior double door, fire rating labeled, possibly in corridor at fire wall*

3 pr Butts
1 Lockset
1 Cylinder
1 Automatic Flush Bolt Set
2 Closers
1 Coordinator
2 Wall Bumper

Set No. 6 – *Heavy duty interior door, possibly industrial area in fire or smoke wall*

4 pr Butts
1 Lockset
2 Cylinder
1 Automatic Flush Bolt Set
2 Closer
1 Coordinator
1 Threshold

Set No. 7 – *Light weight interior single door, possibly to private bathroom*

1 pr Butts
1 Privacy set
1 Wall Bumper

Set No. 8 – *Exterior double door without emergency egress or closers*

3 pr Butts
1 Lockset
1 Cylinder
1 Manual Flush Bolt Set
2 Door Holders

1 Threshold
1 Sweep
1 Weatherstrip Set

PART 3 - EXECUTION

3.1 INSTALLATION. Install hardware in accordance with manufacturer's templates and instructions. Fit hardware accurately and properly, then fasten fixed parts securely for smooth, trouble-free and non-binding operation. Fit faces of mortised parts snug and flush. Install operating parts for free and smooth operation without binding, sticking, or excessive clearance.

Install locksets and latchsets such that bolts automatically engage in keeper, whether activated by closer or by manual push and in no case shall additional manual pressure be required to engage bolts in keeper.

3.1.01 Adjustments. After installation, examine hardware in place for complete and proper installation. Adjust and lubricate bearing surfaces of moving parts. Adjust latching and holding devices for proper function. Adjust door control devices for speed and power. Adjust closers to operate evenly and noiselessly. Have manufacturer's representative regulate closers prior to acceptance.

3.1.02 Protection. Protect hardware from marring and damage of finish during construction. Use removable tapes, strippable coatings, or other means acceptable to Engineer. If hardware is found marred, damaged or defective, then it should be replaced, reworked and corrected.

3.1.03 Cleaning. Make provision for complete removal of protective materials and for thorough cleaning of exposed surfaces of hardware. Prior to final cleaning for acceptance, check hardware for surface damage.

End of Section

SECTION 08800

GLAZING

PART 1 - GENERAL

1.1 SCOPE. This section covers glass and glazing for store front systems, skylights, windows, doors, and other openings having glass as indicated on the drawings and as stipulated herein.

1.2 GENERAL.

1.2.01 Governing Standards.

AAMA (American Architectural Manufacturers Association) 804.1 - Specification for Back Bedding Mastic Type Glazing Tapes.

ASTM (American Society for Testing and Materials) C236 - Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.

ASTM C509 - Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.

ASTM C864 - Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.

ASTM C920 – Specification for Elastomeric Joint Sealants.

ASTM C963 - Specification for Packaging, Identification, Shipment, and Storage of Lock-Strip Gaskets.

ASTM C964 - Guide for Lock-Strip Gasket Glazing.

ASTM C1021 - Practice for Laboratories Engaged in the Testing of Building Sealants.

ASTM C1036 - Specification for Flat Glass.

ASTM C1048 - Specification for Heat Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.

ASTM C1087 - Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.

ASTM C1193 – Standard Guide for Use of Joint Sealants.

ASTM D1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

ASTM E631 - Terminology of Building Constructions.

ASTM E774 - Specification for the Classification of the Durability Sealed Insulating Glass Units.

ANSI (American National Standards Institute, Inc.) Z97.1 - USA Standard Performance Specification and Methods of Test for Transparent Safety Glazing Material Used in Buildings.

16 CFR (Code of Federal Regulations) 1201 – Consumer Product Safety Commission (CPSC) Standard on Architectural Glazing Materials.

FGMA (Flat Glass Marketing Association) Glazing Manual.

FGMA Sealant Manual.

IGCC (Insulating Glass Certification Council) Certified Products Directory.

SGCC (Safety Glazing Certification Council) Certified Products Directory.

SIGMA (Sealed Insulating Glass Manufacturers Association) Practices for Vertical Field Glazing of Organically Sealed Insulating Glass Units.

UL (Underwriters Laboratories Inc.) 9 - Fire Tests of Window Assemblies.

UL 263 – Fire Tests of Building Construction and Materials.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. The work shall be performed by a glazing contractor with 5 years documented experience in store front systems, skylights, and other openings. If requested by Engineer, submit evidence of successful experience on projects similar in size and scope to the Work.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit glass manufacturer's product description with instructions, including limitations, for storage, handling, installation and maintenance of specified glass products, sealants, gaskets, setting blocks, shims, reglets, protective tape and other accessories.

For exterior glazing, submit glass product manufacturer's statement that products meet the specified glass breakage probability requirements for indicated applied loads, that expected thermal stressing of products is acceptable and that glazing details have been reviewed and are approved.

Submit shop drawings of glazing details. Draw details at least full size (twice full size preferred) and indicate dimensions, tolerances, and materials. Submit shop drawings for structural sealant glazing after review and approval of shop drawings by sealant and glass product manufacturers.

1.4.02 Certifications. Submit statement, written on glazing product manufacturer's official letterhead and signed by the responsible representative, stating that glazing products meet the requirements of the specified standards.

1.4.03 Samples. Submit sample for each style of monolithic and laminated glass no less than 3 by 6 inches (7.6 x 15.2 cm), and each style of insulating glass unit no less than 12 by 12 inches (30.5 x 30.5 cm). Include type of edge seal, spacer, and corner construction of spacer. Identify specific type of reflective and low-emissivity coated glasses, coated surfaces, and exterior face of unit.

Submit sample of corner construction of compression gasket for dry glazing with each leg approximately 6 inches (15.2 cm) long. Submit samples, each 6 inches (15.2 cm) long, of tape sealant, compression wedge, channel gasket, reglet, and bed gaskets to be used. Also provide samples of the cured sealant (after color selection has been made). The face shim or spacer, setting block, edge block, protective tape, compressible filler and open cell filter that will be used.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver products to the Project site in original, unopened containers bearing label clearly identifying manufacturer name, brand, and grade.

Store and handle products as recommended by the manufacturer to prevent damage and deterioration. Additionally, store glass products in a cool, dry, shaded, well-ventilated area not subject to condensation, rain, snow or direct sun.
Affix labels to each pane of glass indicating thickness and type. Labels shall remain on glass until final cleaning.

1.6 WARRANTY. Fire resistant glass shall be warranted for 5 years against vision through the unit being adversely affected.

Insulating glass units, glazed no more than 15 degrees from vertical shall be warranted for 10 years against faulty materials and workmanship, including material obstruction of vision as a result of fogging, film formation, dust, or condensation on internal glass surfaces.

Monolithic reflective glass shall be warranted for 10 years against deterioration or peeling of the coating.

Glazing systems installation shall be warranted for a period of 5 years against defective materials and workmanship.

During the warranty period, restore defective Work to the standard of the Contract Documents, including all labor, materials, refinishing and other costs incidental to the Work. Inspect the Work within 24 hours after receipt of notice from the owner and immediately repair leaks. Restore Work found to be defective within 2 weeks.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Take field measurements to verify or supplement required dimensions.

Do not install sealant in damp or dusty weather, when ambient temperature is below 40 degrees F (4.4 degrees C), or when joint substrates are damp or wet due to rain, frost, condensation or other causes.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.2.01 Monolithic Glass. Style M1 shall be Clear - Type I, Class 1, Condition A, Kind HS, 1/4 inch (6.4 mm) thick glass. Winter nighttime U-value shall be a maximum of 1.13. Summer daytime U-value shall be a maximum of 1.03. Shading coefficient shall be maximum of 0.96. Visible light transmittance shall be a minimum of 88 percent.

Style M2 shall be Tinted - Type 1 Class 2, Kind HS, gray tint, 1/4 inch thick (6.4 mm). Winter nighttime U-value shall be a maximum of 1.13. Summer daytime U-value shall be a maximum of 1.10. Shading coefficient shall be a maximum of 0.71. Visible light transmittance shall be a minimum of 37 percent.

Style M3 shall be Wired - Type II, Class 1, Form 1, Mesh M1, 1/4 inch (6.4 mm) thick glass.

Style M4 shall be Patterned - Type II, Class 1, Form 3, Finish f1, nominal 1/4 inch (6.4 mm) thick glass.

2.2.02 Insulating Glass. Shall be Tinted - Both panes of Type I, Class 2, condition A, Kind HS, gray tint, 1/4 inch (6.4 mm) thick glass with both panes Condition A, Kind HS. Winter nighttime U-value shall be the maximum of 0.50. Summer daytime U-value shall be the maximum of 0.59. Shading coefficient shall be the maximum of 0.58. Visible light transmittance shall be the minimum of 36 percent.

2.3 ACCEPTABLE MANUFACTURERS.

2.3.01 Monolithic Glass, Types M1 and M2. Acceptable manufacturers include Guardian Industries Corp; Libbey-Owens-Ford Co.; PPG Industries, Inc., or equal.

2.3.02 Monolithic Glass, Type M3. Acceptable manufacturers include Hordis Brothers, Inc.; AFG Industries, Inc.; or equal.

2.3.03 Monolithic Glass Type M4. Acceptable manufacturers include AFG Industries, or equal.

2.3.04 Insulating Glass. Acceptable manufacturers include Cardinal IG; PPG Industries, Inc.; Guardian Industries Corp.; or equal.

2.3.05 Single Sources. Provide glass products produced by a single manufacturer for each condition and kind of glass and composed of primary glass obtained from a single source for each type and class specified.

2.3.06 Sealants. Acceptable manufacturers include Dow Corning, General Electric, Trevco, Proglaze, Spectrin, or equal.

2.3.07 Gaskets and Accessories. Acceptable manufacturers include D.S. Brown Co., Cadillac Rubber and Plastics, Inc., Variseal, Inc., or equal.

2.4 MATERIALS.

2.4.01 Glass. Provide products conforming to references and as specified.

2.4.02 Primary Glass. Shall comply with ASTM C1036 and be fully annealed unless otherwise specified. Float glass shall have a quality of q3. Wired and patterned glass shall have a quality of q8.

Do not exceed a probability of 8 glass breakages per 1000 units for monolithic and laminated glass and 8 per 1000 units or openings for insulating glass units, when glazed no more than 15 degrees from vertical based on listed glass usage, when designed to resist wind loads, thermal stressing, and snow loads where applicable.

Do not exceed a probability of 1 glass breakage per 1000 for glass products glazed more than 15 degrees from vertical, based on listed glass usage, when designed to resist wind loads, thermal stressing, and snow loads where applicable.

2.4.03 Heat-Treated Glass. Shall comply with ASTM C1048; except the surface compression stress level for Kind HS glass shall be not less than 3500 psi (24.1 MPa) or greater than 7500 psi (51.7 MPa). Glass shall be heat-treated by horizontal roller process with roll wave distortion parallel to bottom edge of glass when installed, unless otherwise specified.

2.4.04 Insulating Glass. Shall be hermetically sealed with 1/2 inch (1.3 cm) air space, listed in the IGCC Certified Products Directory and with appropriate IGCC Certification mark on spacer or at least one pane of unit, certified as passing Class CBA performance as determined by ASTM E774.

Units for non-structural sealant glazing applications shall be of dual seal construction with a polyisobutylene primary seal and a polysulfide, polyurethane or silicone secondary seal.

Units which will be shipped through or glazed at altitudes of 5000 feet (1524.0 m) or more above sea level shall be fabricated with breather or capillary tubes, to permit air space pressure equalization. Provide same warranty as for non-breather or capillary tube units. Pinch tubes during glazing if required by glass manufacturer.

2.4.05 Safety Glass. Shall comply with ANSI Z97.1 and testing requirements of CPSC 16 CFR part 1201, and listed in the SGCC Certified Products Directory with appropriate SGCC certification mark or label permanently affixed.

Furnish safety glass for glass occurring in doors and sidelights, and where required by authorities having jurisdiction.

2.4.06. Wired Glass. Shall be fire resistance rated, tested per ASTM E163 or UL 9 and labeled and listed by UL or other agency acceptable to authorities having jurisdiction.

2.5 GLAZING PRODUCTS. Glazing products such as sealants, tapes, gaskets and accessories shall be compatible with each other and with other products with which they will come into contact, including glass products, seals of insulating glass units, polyvinyl butyl interlayer of laminated glass, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and experience. Submit proof of compatibility where specified.

Comply with recommendations of sealant, tape, glass, and gasket manufacturers, unless otherwise specified, for selection of glazing products and glazing systems which have performance characteristics suitable for applications indicated and conditions at time of installation. Submit glazing system for review.

2.5.01 Sealants. For non-structural exposed and concealed locations, use single-component, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, Use NT, Uses A, G and O; Dow Corning, 795 or 999-A; General Electric, Gesil-N or Construction 1200; Tremco, Proglaze or Spectrem 2; or equal. Color shall be black.

2.5.02 Tape Sealants. For openings up to 75 united inches (190.5 cm), use preformed, solvent free, 100 percent solids, unshimmed, butyl-polyisobutylene tape that is non-staining and non-migrating when in contact with nonporous surfaces and that complies with AAMA 804.1; Pecora, Extru-Seal; PTI, 303 Glazing Tape; Tremco, 440 Tape; or equal.

For openings over 75 united inches (190.5 cm), use a preformed, solvent free, 100 percent solids, pre-shimmed, butyl-polyisobutylene tape that is non-staining and non-migrating when in contact with nonporous surfaces and that complies with AAMA 804.1; Pecora, Shim-Seal; PTI, 303 Shim Tape; Tremco, Pre-Shimmed 440 Tape; or equal.

2.5.03 Gaskets. Shall be extruded, closed cell, neoprene, EPDM or silicone rubber, in compliance with ASTM C509, as recommended by glazing and sealing systems manufacturer.

Bed gasket for wet glazing system shall be continuous with pressure sensitive adhesive one side, designed to be compressed 25-40 percent in the opening.

Compression gasket for dry glazing system shall be shaped as required to be compressed in place a minimum of 25 percent and of one-piece construction with factory-assembled frames with injection-molded, vulcanized corners; produced oversize in opening dimension, as determined by measurements, to insure compression at corners but within limits so that compression does not create a "pucker".

Channel gasket shall be continuous channel of shape and dimensions for application in the opening with specified glazing, constructed of extruded dense neoprene EPDM or silicone rubber.

Compression wedge for dry glazing system shall be 70 plus/minus 5 Shore "A" durometer, of shape and size to compress the exterior compression gasket a minimum of 25 percent, and as recommended by glazing and sealing systems manufacturer.

2.5.04 Accessories. Setting block shall be 85 plus/minus 5 Shore "A" durometer, each block properly sized for load, as wide or wider than glazing, no less than 4 inches (10.2 cm) long, except in lock-strip gaskets no less than 6 inches (15.2 cm) long; profile to permit friction fit, dart insertion into metal chair, or pressure sensitive adhesive one side to fix block in glazing opening.

Edge block shall be 40 to 60 Shore "A" durometer, each block a minimum of 4 inches (10.2 cm) long, as wide as glazing, placed in the vertical glazing channel, and sized to allow a nominal 1/8 inch (3.2 mm) clearance between glass edge and installed block; profile to permit friction fit or pressure sensitive adhesive one side to fix block in glazing opening.

Face shim or spacer shall be 40 to 60 Shore "A" durometer, continuous in glazing opening; profile to permit friction fit, dart insertion or pressure sensitive adhesive one side to fix shim or spacer in location.

Oil-free cleaning solvents (for example: toluene, xylene, methyl ethyl ketone, acetone and mineral spirits) and use as recommended by the sealant manufacturer; furnished in containers for cleaning solvent storage that are clean, oil-free and suitable for use with the solvent.

Primer shall be a nonstaining product of sealant manufacturer for use when recommended and as specified for the application by the sealant manufacturer.

Compressible filler shall be expanded open cell polyurethane shape compressed a minimum of 25 percent of its dimension at time of installation in the opening; plateau supply Co., Denver Foam; Industrial Thermo Polymers Limited, Tundra Foam; or equal.

Expanded closed cell polyethylene shape compressed no more than 25 to 33 percent of its dimension at the time of installation in the opening; Industrial Thermo Polymers Limited, ITP Standard Backer Rod; Nomaco, Inc., Green Rod; W.R. Meadows, Inc., Sealtight Backer Rod; or equal.

Open cell filter shall be reticulated flexible polyester urethane foam having 20 pores per inch (2.5 cm), sized at least 1 inch (2.5 cm) larger in dimension then weephole, of cross section to provide 15 to 25 percent compression for friction fit and as manufactured by Foam Division, Scott Paper Co.; or equal.

Bond breaker shall be heavy duty, 14 mil (0.36 mm) minimum thickness, colored, polyethylene or teflon, self-adhesive bond breaker of type recommended by sealant manufacturer and suitable for conditions of usage. Liquid bond breaker is not permitted.

2.6 MANUFACTURE AND FABRICATION. Sizes required for glazing openings shall meet glass edge clearances, tolerances, and edge conditions complying with recommendations of glass manufacturer, be of thicknesses required or as recommended by glass manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION. Protect the Work and adjacent construction against damage during progress of the Work.

Protect glass surfaces and edges from damage during storage, handling and installation. Use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass within openings; do not raise or drift glass with a pry bar. Rotate glass with flares or bevels along one horizontal edge which would occur in vicinity of setting blocks so that these are located at top of opening. Remove from Project and dispose of glass with edge damage or other imperfections that exceed glass manufacturer's recommendations or of type that, when installed, weakens glass and impairs performance and appearance.

3.2 INSTALLATION.

3.2.01 Application. Inspect Work of window or glass framing erector for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners; for presence and functioning of weep system; for existence of minimum required face or edge clearances; and for effective sealing of joinery. Do not allow glazing work to proceed until unsatisfactory conditions, as required in writing by glazier, have been corrected.

Installation, including preparation, definition of terms, glass positioning, edge clearances and tolerances, setting and application of glazing materials shall comply with the minimum requirements of listed references of the FGMA, SIGMA and ASTM. Support and cushion glass in the glazing channel to prevent point loading, rotational forces and excessive clamping pressure.

Comply with combined printed recommendations of glass manufacturers, of manufacturers of sealants, gaskets and other glazing materials, except where more stringent requirements are indicated, including those of referenced glazing standards.

Do not install insulating, laminated or wired glass, that is exposed to moisture, in glazing channels that are not provided with weepholes. Do not allow glazing work to proceed until corrected.

Apply primers to joint surfaces if required for adhesion of sealants, as determined from preconstruction testing by sealant manufacturer.

Clean glazing channels and other framing members that receive glass, immediately before glazing. Remove coatings which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are required.

Do not install exterior glass until sand-blasting, bushhammering, grouting, waterproofing and similar work on surrounding concrete is completed.

Install setting blocks of proper size in glazing channel, located one quarter of glass width from each corner, but with block edge nearest corner no closer than 6 inches (15.2 cm) from corner, unless otherwise specified or required by glass manufacturer.

Install spacer where required of correct size to preserve required face clearances except where gaskets or preshimmed glazing tapes are used for glazing. Provide 1/8 inch (3.2 mm) minimum bite of spacer on glass and use thickness equal to sealant width.

Install edge blocking to comply with requirements of referenced glazing standards, except where otherwise specified or required by glass manufacturer.

Install compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glazing channel or weep systems as well as to control depth of sealant for optimum performance, unless otherwise specified.

Install sealants in compliance with ASTM C804 and C962. Force sealant into glazing channels to eliminate voids and to ensure complete "wetting" or adhesion of sealant to glass and channel surfaces. Tool exposed surface of sealant to provide a 1/16 inch (1.6 mm) high watershed away from glass.

Drive wedge-shaped gaskets into one side of glazing channel to compress sealant or gasket on opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when installation is subjected to movement. Miter cut wedge-shaped gaskets at corners and install in manner recommended by gasket manufacturer to prevent pull away at corners; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

For dry pressure glazing, install glass in metal windows or framing with compression gasket applied to stationary stop and compressed a minimum of 25 percent, edge blocking at jambs, open cell filter foam centered behind weep holes, and compression wedge locked into removable stop. Clamping pressure of glazing system shall be a uniform 4 to 6 pounds per lineal inch (0.7 – 1.1 kg per lineal cm), and in no case to exceed 10 pounds per lineal inch (1.8 kg per lineal cm).

For glazing hollow metal moors and frames, install glass with tape sealant full depth of stop, with setting blocks and metal stops.

For glazing aluminum doors and frames, install glass in aluminum doors and frames with gaskets and metal stops furnished with doors and frames and installed in accordance with door and frame manufacturer's recommendations. Glaze doors in closed position.

3.2.02 Cleaning. Examine glass surfaces adjacent to or below exterior concrete, other masonry surfaces, and weathering steel at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkali deposits or staining. When examination reveals presence of these forms of residue, remove by method recommended by glass manufacturer.

Remove nonpermanent labels and clean glass surfaces, by cleaning both faces using non-abrasive cleaners and procedures, not more than 4 days prior to date scheduled for inspections that are intended to establish date of substantial completion, in each area of Project. Clean glass by method recommended by glass manufacturer.

3.2.03 Protection. Protect exterior glass from breakage immediately upon installation by use of crossed streamers attached to framing and held away from glass. Do not apply markers to surfaces of glass.

Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction, including natural causes, accidents and vandalism.

Protect glass with screens of appropriate barrier material wherever welding, cutting or other potentially damaging work is performed.

Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances come into contact with glass, remove immediately by method recommended by glass manufacturer.

End of Section

INDEX

DIVISION 9 – FINISHES

SECTION 09100

FRAMING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. Section includes non-loading metal stud framing and accessories for partition walls at interior locations.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) A123/A123M – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A653/A653M – Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A591/A591M – Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications.

ASTM C645 – Specification for Nonstructural Steel Framing Members.

ASTM C754 - Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board.

ASTM C1002 – Specification for Steel Self – Piercing Tapping Screws for the Application of Gypsum Panel Products for Metal Plaster Bases to Wood Studs or Steel Studs.

ML/SFA 540 - (Metal Lath/Steel Framing Association, Division of National Association of Architectural Metal Manufacturers) – Lightweight Steel Framing Manual.

SSPC Paint 20 (Steel Structures Painting Council) – Zinc Rich Primers.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer's Qualification. Company shall be manufacturer specializing in products with minimum of 5 years documented experience.

1.3.02 Contractor's Qualifications. Company shall have a minimum of 5 years documented experience performing Work of this type and scope.

1.3.03 Tolerances. Maximum Variation from True Position shall be 1/8 inch (3.2 mm) in 10 feet (3.0 m). Maximum Variation from Plumb shall be 1/8 inch (3.2 mm) in 10 feet (3.0 m).

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings that indicate prefabricated work, component details, stud layout, framed openings, anchorage to structure, type and location of fasteners, and accessories required for related work. Submit data describing standard framing member materials and finish, product criteria, load charts, and limitations. Submit manufacturer's installation instructions as well as special procedures or perimeter conditions requiring special attention. Describe method for securing stud to tracks, splicing, blocking, and reinforcing to framing connections.

Provide calculations for loadings and stresses of exterior walls or specially fabricated framing. Design structural elements under direct supervision of a professional engineer experienced in design of this type of Work and licensed in the State of Michigan.

1.4.02 Mock-Up. Provide mock-up of stud wall framing including insulation, sheathing, door frame, or other opening and interior and exterior finish. Mock-up size shall be 12 feet (3.7 m) long and full height including corner. Mock-up may remain as part of the Work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Shall include Clark Steel Framing Systems, Dietrich Industries, Inc., Harrison Manufacturing Co., Marino/Ware, Unimast Incorporated, or approved equal.

2.2 MATERIALS. Non-load bearing studs shall be AS2S, galvanized to C-90 coating class, ANSI/ASTM A591, rolled steel, channel shaped, punched for utility access, as required.

Tracks and Headers shall be same material and thickness as studs. Furring and Bracing Members shall be of same material as studs with thickness to suit purpose. Sheet Metal Backing shall be 20 gauge (1.0 mm) galvanized steel for reinforcement. Touch-Up Primer for Galvanized Surfaces shall be FSTT-P-645.

Fasteners shall be ASTM C1002, self drilling and self tapping screws. Anchorage Devices shall be screws with sleeves.

2.3 MANUFACTURE AND FABRICATION. Fabricate assemblies of framed sections to sizes and profiles required. Fit, reinforce, and brace framing members to suit design requirements.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that all conditions are ready to receive Work. Verify that all field measurements are as shown on approved architectural drawings. Verify that rough-in utilities are in proper location.

3.2 INSTALLATION.

3.2.01 Erection. Perform Work in accordance with ASTM C754 and ML/SFA 540. Form, fabricate, install, and connect components in accordance with ML/SFA 540.

Align and secure top and bottom runners at 24 inches (61.0 cm) on center. Place two beads of acoustic sealant between runners and substrate to achieve a vapor seal. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

Install studs vertically at 16 inches (40.6 cm), on center. Align stud web openings horizontally.

Secure studs to tracks using clip and tie method. Do not weld studs.

Stud splicing is permissible. Splice studs with 8 inch (20.3 cm) nested overlap, secure each stud flange with flush head screw.

Brace stud framing system as required.
Coordinate erection of studs with requirements of door frames, window frames, installation supports, and attachments (Fabricate corners using a minimum of three studs). (Double stud at wall openings, door and window jambs, not more than 2 inches (61.0 cm) from each side of openings.).

Coordinate installation of wood bucks, anchors, and wood blocking with electrical and mechanical work to be placed within or behind stud framing.

Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, and hardware.

End of Section

SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 – GENERAL

1.1 SCOPE. This section covers gypsum wallboard partitions and ceilings to be furnished and installed at the locations indicated on the drawings. Other accessories include metal furring, framing, ceiling suspension system and accessories,

1.2 GENERAL.

1.2.01 Governing Standards.

ADA (Americans With Disabilities Act) 36 CFR 1191 – Accessibility Guidelines for Buildings and Facilities; Final Guidelines.

AIAFRR (American Insurance Association Fire Resistance Ratings).

AMA (Acoustical Materials Association) 1-II – Ceiling Sound Transmission Test by Two-Room Method.

ASTM (American Society for Testing and Materials) A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM C36/C36M – Specification for Gypsum Wallboard.

ASTM C475 – Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

ASTM C630/C630M – Specification for Water-Resistant Gypsum Backing Board.

ASTM C645 – Specification for Nonstructural Steel Framing Members.

ASTM C665 – Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

ASTM C754 – Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Board.

ASTM C840 – Specification for Application and Finishing of Gypsum Board.

ASTM C1047 - Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.

ASTM E90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

ASTM E119 – Test Method for Fire Tire Tests of Building Construction and Materials.

Fire Resistance Directory – Specified gypsum wallboard materials manufacturer's printed specifications and product data.

GA (Gypsum Association) – GA-214 – Levels of Gypsum Board Finish.

UL (Underwriters Laboratories Inc.) – Building Materials Directory.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor's Qualifications. Work shall be performed by a Company specializing in gypsum board systems work with a minimum of 5 years experience.

1.3.02 Tolerances. Maximum variation from true flatness shall not exceed 1/8 inch (3.2 mm) in 10 feet (3.0 m) in any direction.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit Shop Drawings for reinforced gypsum showing details of fabrication and installation.

Submit product data for ceiling hangers attachment devices showing description of proposed use and safe working loads.

1.4.02 Certification. Contractor shall submit a statement of compliance for materials and methods of installation for fire-rated construction and sound-attenuating construction.

The Contractor shall submit in triplicate a notarized certificate, addressed to the State Fire Marshal or other authority having jurisdiction over the Project, stating that the materials for fire-rated assemblies for the Project have been installed in accordance with the UL design number or other testing authority number submitted.

1.4.03 Test Reports. Submit in duplicate a testing laboratory report for fire-rated assemblies, showing details of construction, including control joints. One will be returned for use by the Contractor.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver manufactured materials to job in their original packages, containers or bundles with manufacturer's name, brand name, grade, UL listing, and other pertinent data clearly marked.

Store materials in a dry place providing protection from damage and exposure to the elements. Stack gypsum board flat, supported along its full width and length to prevent sagging, and neatly to prevent damage to edges, ends and surfaces.

Store reinforced gypsum shapes in an approved area free from excessive moisture in manufacturer's crates, or in crated position with duplicate supports as originally crated.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Provide appropriate heat, ventilation and humidity control as required in gypsum board application areas prior to, during and following application of gypsum board, joint finishing materials or bonding adhesives. Maintain temperatures within the building at the application areas between 55 and 70 degrees F (12 and 21 degrees C).

2.2 PERFORMANCE REQUIREMENTS.

2.2.01 Horizontal Load Resistance. Except for cavity shaft wall for elevator shafts, when a uniformly distributed horizontal load of 5 pounds per square foot (24.4 kg per m^2) is applied normal to one side of the wall, limit the maximum deflection in the studs or furring to 1/360 of the unsupported span.

2.2.02 Fire-Rated Construction. Provide materials and methods of installation for fire-rated construction which comply with requirements of American Insurance Association "Fire Resistance Ratings" publication, UL "Fire Resistance Directory", or other test authority: specify fire resistance classification, UL design number, or other authority test number as appropriate.

The Contractor shall submit requests for deviations from the approved test assembly and obtain written approval of the State Fire Marshal and the Engineer.

2.3 ACCEPTABLE MANUFACTURERS.

2.3.01 Steel Framing and Furring. Utilize products of Dietrick Industries, Inc.; Gold Bond Building Products Div.; National Gypsum Co.; Unimast Inc.; or approved equal.

2.3.02 Grid Suspension Assemblies. Utilize products of Chicago Metallic Corp.; National Rolling Mills Co.; USG Interiors, Inc.; or approved equal.

2.3.03 Gypsum Wallboard and Related Products. Utilize products of Georgia-Pacific Corp. (G-P); Gold Bond Building Products Div.; National Gypsum Co. (National); United States Gypsum Co. (USG); or approved equal.

2.3.04 Steel Reinforcing. Utilize products of Metal Lite Inc. or approved equal.

2.4 MATERIALS. The suspension system and metal furring materials shall comply with ASTM C754 and the following:

Carrying channels shall be 1-1/2 inch (3.8 cm) size, cold-rolled steel, galvanized or asphaltum-painted.

Rigid furring channels shall be hat-shaped, minimum 2-5/8 inches (6.7 cm) wide by 7/8 inch (2.2 cm) deep, roll-formed from 25 gauge (0.625 mm) thick electro-galvanized steel sheets.

Adjustable furring brackets shall be formed from 20 gauge (1.0 mm) galvanized steel sheet, 1 inch wide, designed to provide furring depth of up to 2 1/4 inches (5.7 cm) for braced furring attached to masonry or concrete.

Hangers for supporting carrying channels from building construction shall be minimum 9 gage (3.9 mm) galvanized steel wire, soft temper, straightened.

Tie Wire for lacing and attaching rigid furring channels to carrying channels in ceiling construction shall be 16 gauge (1.6 mm) soft temper, galvanized steel wire. Zinc-coated clips of cold drawn spring steel wire not lighter than 12 gage (2.75 mm) may be substituted for tie wire when allowed by fire resistance test.

2.4.01 Metal Wall Framing Studs. Shall be non-load-bearing-channel type, cold-formed from galvanized steel sheet, minimum 25 gauge (0.625 mm), unless otherwise specified or indicated, and complying with ASTM C645. Provide minimum 20 gauge (1.0 mm) studs for the following:

Double studs at door jambs and the first stud in the partition beyond door jamb.

Studs to which cementitious backer units for wet areas, are attached.

Studs to which wall-mounted equipment, including Owner-furnished equipment, is fastened.

Furnish metal studs complete with floor and ceiling tracks, accessories including suitable shapes and connections for framing around openings and elsewhere as may be required for the anchorage of attachments. Other component standards shall be used with the metal stud manufacturer for the type, sizes, and application of studs used.

Accessories shall be galvanized or factory prime coat painted with rust-inhibitive paint.

Except for fire-rated construction, provide standard web cutouts located 12 inches (30.5 cm) from each end, and additional cutouts in width not greater than 75 percent of width of web, located at 24, 36, 48 and 60 inches (61.0, 91.4, 121.9, and 152.4 cm) from bottom of stud.

For fire-rated construction, provide cutouts as in the approved test assembly.

2.4.02 <u>Steel Reinforcing</u>. For handrails and grab bars, comply with ADA, Section 4.26.

2.4.03 <u>Acoustical Sealing Compound</u>. Use an appropriate sealant identified per manufacturer's specifications.

2.4.04 <u>Gypsum Wallboard</u>. Shall be ASTM C36, of thickness indicated, 48 inches (121.9 cm) wide, in lengths as required to suit the application and to minimize joints, with tapered edge and paintable exposed face.

Gypsum wallboard to which ceramic tile will be applied in dry areas shall be water-resistant type complying with ASTM C630.

Gypsum wallboard for fire-rated construction shall be listed in the UL Building Materials Directory and bear the UL classification marking or listing mark.

Exterior gypsum soffit board shall be a gypsum core soffit panel with additives to enhance fire-resistance of the core; surfaced with water repellant paper on front, back and long edges; and complying with ASTM 931, Type X.

2.4.05 <u>Wallboard Accessories</u>. Size wallboard accessories as required for the wallboard thickness and application.

Screws shall be self-drilling, self-tapping, gypsum wallboard screws.

Cornerbeads, edge trims, and control joints shall comply with ASTM C1047.

Flexible dust membrane shall be 4 mil (0.1 mm) polyethylene sheet or as recommended by gypsum wallboard manufacturer.

2.4.06 Finishing Materials. Finishing materials, including joint tape and embedding and finishing types of joint compound shall be the products of a single manufacturer and complying with ASTM C475.

2.4.07 Sound-Attenuating Blanket. Shall be glass or mineral fiber complying with ASTM C665, Type I, 2.5 pcf (40.0 kg per cu m) density, of size to fit from web to web of metal studs, 2 or 2 1/2 inches (5.1 or 16.1 cm) thick and having maximum fire hazard classification, when tested in accordance with ASTM E84, of 25 for flame spread and 50 for smoke developed.

2.4.08 Reinforced Gypsum. Shall be shop fabricated of high strength gypsum cement reinforced with glass fibers, 1/8 inch (3.2 mm) minimum thickness, with tapered edges, as manufactured by DecoForm Corp.; Formglas Inc.; Plasterform, Inc.; Plastrglas, Inc. or approved equal. Provide shapes complete with necessary integral stiffeners and attachment devices. Exposed surfaces shall be smooth and ready to receive field painting.

PART 3 - EXECUTION

3.1 PREPARATION. Protect adjacent construction with suitable covering or other method during progress of the Work until completion. Coordinate this Work with other trades to prevent delays and conflicts in scheduling.

3.2 INSTALLATION SUPPORT SYSTEMS.

3.2.01 Metal Support Systems. Install metal support systems in accordance with ASTM C754 and manufacturer's printed directions, unless otherwise specified.

3.2.02 Ceiling Suspension System. Where required to obtain the indicated ceiling heights or to meet specific conditions, provide carrying channels attached to, or wire hanger suspended from building construction. Provide approved hanger attachment devices. Do not support hangers from roof deck.

Space and support carrying channels will not be more than 48 inches (121.9 cm) each way, unless otherwise required to meet fire resistance ratings.

Brace and secure carrying channels in position, true and rigid and in a manner to prevent deflection. Keep carrying channels free of wall and other building elements.

Install furring channels at right angles to supporting members and secured with wire clips or 2 loops of tie-wire at such intervals that the span of furring channels nowhere exceeds 48 inches (121.9 cm). Secure furring channels to structural members if carrying channels are not used.

Space furring channels not more than 16 inches (40.6 cm) center-to-center. Join furring channels by nesting channels not less than 8 inches (20.3 cm) and securely tying with double loops of tie-wire. Locate the first, last and ends of furring channels approximately 2 inches (5.1 cm) from walls and other building elements.

3.2.03 Vertical Furring. Provide steel shapes, clips, crimped band iron, wire and other attachments necessary to bring wallboard to lines indicated. Install metal furring at maximum spacing of 24 inches (61.0 cm).

Install wall furring vertically and rigidly attached to the substrate, or to furring channels attached to adjustable furring brackets where required to provide furring depth indicated.

3.2.04 Metal Stud Partitions. Position metal studs vertically in tracks, spaced 16 inches (40.6 cm) on centers, or less where otherwise indicated or required. Double studs toe to toe shall be installed at jambs of hollow metal door frames, accurately centered and attached to anchor clips with bolts or screws. The next stud shall be not over 6 inches (15.2 cm) away from the double stud. Over openings, install a cut-to-length section of track, with web flange bent at each end, to receive metal studs over the opening. Construct partitions extending full height from floor to ceiling to interrupt the ceiling system, unless otherwise indicated.

3.2.05 Soffits. Anchor tracks to steel framing. Position metal studs in tracks, spaced 16 inches (40.6 cm) on centers and not more than 2 inches (5.1 cm) from ends of soffit.

3.2.06 Fire Rated Construction. Extend fire-rated construction from floor to underside of floor or roof construction above, unless otherwise indicated. In addition to partitions indicated to be fire-rated, provide fire-rated construction for Smoke barrier partitions, Corridor partitions, and Partitions between sprinklered rooms and non-sprinklered rooms.

Do not enlarge existing holes or provide additional holes in studs.

3.2.07 Metal Stud Chase Walls. For chase wall construction, place a double row of tracks parallel and spaced as indicated, but not more than 24 inches (61.0 cm) on center.

Position a double row of metal studs vertically in the tracks spaced 16 inches (40.6) on center and so that pairs of studs are opposite each other with the flanges pointing in the same direction.

Place cross bracing of one of the following types, at the center of partition height for each pair of studs, but not exceeding 48 inch (121.9) spacing:

Gypsum wallboard, 12 inches (30.5 cm) wide, attached to each stud with a minimum of three Type S screws.

Section of 2 1/2 inch (6.4 cm) metal stud, attached to each stud with a minimum of two sheet metal screws.

3.2.08 Steel Reinforcing. Provide steel reinforcing, or fire-treated wood blocking, for wall-mounted equipment fastened to face of studs at locations indicated and as follows:

For attachment of wall cabinets.

For attachment of surface-mounted toilet and bath accessories.

For attachment of wall-mounted door stops.

At resilient base.

Where toilet compartment door bumpers hit the wall.

At pipe cutouts.

For attachment of handrails.

For attachment of grab bars and urinal screens.

Install reinforcing so that face of studs and face of reinforcing are flush.

3.2.09 Double Stud Assemblies. Provide double stud assemblies where indicated, consisting of two studs back to back, anchored together with sheet metal screws at 12 inch (30.5 cm) spacing, staggered in web.

3.3 INSTALLATION WALLBOARD SYSTEMS.

3.3.01 Gypsum Wallboard. Apply gypsum wallboard in accordance with ASTM C840, unless otherwise specified.

3.3.02 Ceilings and Soffits. Apply wallboard with the long dimension at right angles to furring channels or studs, unless otherwise required by the testing authority for the fire-rated system approved for use on the project. Abutting ends and edges shall occur over a furring channel or stud. Use wallboard of the maximum practicable length to minimize end joints. End joints shall be neatly fitted and staggered. Properly support wallboard around all cutouts. At completion, surface of wallboard shall be flush and level. Do not use felt pens or other marking media on exposed face of wallboard that will bleed through final finishing.

3.3.03 Partitions and Vertical Surfaces. Apply wallboard with long or short dimension against stud flanges and furring channels, with joints on opposite sides of partition arranged to occur on different studs and end joints neatly fitted and staggered. Properly support wallboard around all cut-outs.

For double layer fire-rated partitions, apply second layer of wallboard vertically over the first layer, with joints offset from first layer, and laminated thereto with joint compound, or otherwise secured by a method allowed by the testing authority for the fire-rated system approved for use on this Project.

Maximum variation from true flatness shall be less than 1/8 inch (3.2 mm) in 10 feet (3.0 m) in any direction.

3.3.04 Grouting Frames. Fill hollow metal frames in stud partitions solid with gypsum sand plaster grout, proportioned 1 to 3, to the depth into which the wallboard will be inserted into the frame.

3.3.05 Fastening Wallboard. Space screw fasteners a maximum of 12 inches (30.5 cm) on centers in wallboard field and 8 inches (20.3 cm) on centers staggered along abutting edges and ends. Space fasteners not less than 3/8 inch (9.5 mm) from edges and ends of wallboard. Screws shall be power-driven in accordance with gypsum wallboard manufacturer's directions.

3.3.06 Reinforced Gypsum. Install in accordance with manufacturer’s recommendations and approved shop drawings. Treat joints as specified for wallboard.

3.4 INSTALLATION OF WALLBOARD ACCESSORIES. Set wallboard accessories plumb and level and secure in a substantial manner. Make exposed joints of wallboard accessories close and tight.

3.4.01 Control Joints. Isolate gypsum wallboard from all structural elements except floors, by control joint beads or edge trim. Locate control joints where indicated and as follows:

At all changes in type of substrate.

At control or expansion joints occurring in building construction.

In large ceiling areas, not over 50 feet (15.2 m) in either direction and to divide ceiling into rectangular areas of not over 2,500 square feet (232.3 sq m).

In long partition runs, such as corridors, at maximum spacing of 30 feet (9.1 m).

Where wallboard abuts a wall or ceiling of dissimilar construction.

At door frames in stud partitions and furred walls from top of frame to top of wallboard, at both jambs and both sides of partition.

Construct control joints in fire-rated assemblies as detailed in the submitted testing laboratory report.

3.4.02 Corner Beads. Provide corner beads at vertical and horizontal external corners.

3.4.03 Edge Trim. Provide edge trim at the intersection of wallboard surfaces with exterior walls, including furred wallboard construction.

Provide edge trim where ceiling abuts a structural element, dissimilar wall or partition assembly or other vertical penetration, except interior metal stud and wallboard partitions.

3.4.04 Dust Membrane. Provide flexible dust membrane at internal corner formed by wallboard ceiling and wallboard furring on exterior wall.

3.4.05 Finish. Finish gypsum wallboard, to conceal joints and depressions including sanding of final coat, to comply with ASTM C840. Provide levels of finish, as defined in GA-214.

3.5 QUALITY CONTROL.

3.5.01 Penetrations. Box in items which penetrate fire-rated walls or ceilings with same materials that form the wall or ceiling. Support box from structural system of wall or ceiling and not from the penetrating object.

Provide framing in wall and suspension system for the support of lighting fixtures, grilles, diffusers, and other penetrating items.

3.5.02 Sound-Attenuating Construction. Construct partitions indicated to be sound-attenuating to provide a minimum STC of 45 when tested in accordance with ASTM E90. Attach sound attenuation blanket within the stud space to one side of the partition.

Install sound attenuating blanket between studs from floor to ceiling in partitions, which contain plumbing supply or drain lines.

Apply acoustical sealing compound in two parallel beads, 3/8 inch (.9525 cm) in diameter, at each side of runner tracks at juncture with floors, construction above, dissimilar walls, structural elements, around perimeter or back of outlet boxes, and other items penetrating the wallboard. These beads shall be concealed by subsequent construction.

3.6 CLEANING. At the completion of the Work, leave finished space clean, dust free, and in acceptable condition.

End of Section

SECTION 09300

FLOOR COVERINGS

PART 1 – GENERAL

1.1 SCOPE. This section covers flooring finishes to include vinyl composition tile, ceramic tile, and carpeting. Ceramic tile for walls is also addressed.

1.2 GENERAL.

1.2.01 Governing Standards.

AATCC (American Association of Textile Chemists and Colorists) - Test Method 8 – Colorfastness to Crocking: Crocking Meter Method (Wet and Dry Crock).

AATCC Test Method 16E – Colorfastness to Light: Water-Cooled Xenon-Arc Lamp Continuous Light.

AATCC Test Method 134 – Electrostatic Propensity of Carpets.

ANSI (American National Standards Institute, Inc.) A10.20 – Safety Requirements for Ceramic Tile, Terrazzo and Marble Work.

ANSI A108.1C – Contractor's Option - Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Bed with Dry-Set or Latex Portland Cement Mortar.

ANSI A108.4 – Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesive.

ANSI A108.5 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar.

ANSI A108.10 – Installation of Grout in Tile Work .

ANSI A108.11 – Interior Installation of Cementitious Backer Units.

ANSI A118.1 – Specifications for Dry-Set Portland Cement Mortar.

ANSI A118.4 – Specifications for Latex Portland Cement Mortar.

ANSI A118.6 – Specifications for Ceramic Tile Grouts.

ANSI A136.1 – Organic Adhesives for Installation of Ceramic Tile.

ANSI A137.1 – Specification for Ceramic Tile.

ASTM (American Society for Testing and Materials) A185 – Specifications for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

ASTM C144 – Specifications for Aggregate for Masonry Mortar.

ASTM C150 – Specification for Portland Cement.

ASTM C206 – Specification for Finishing Hydrated Lime.

ASTM C207 – Specification for Hydrated Lime for Masonry Purposes.

ASTM C1028 – Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.

ASTM D2261 – Test Method for Tearing Strength of Woven Fabrics by the Tongue (single rip) Method (Constant-Rate-of-Extension Tensile Testing Machine).

ASTM D2646 – Test Methods for Backing Fabrics Characteristics of Pile Yarn Floor Coverings.

ASTM E648 – Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.

Fed. Spec. (Federal Specifications) SS-T-312B – Tile, Floor, Asphalt, Rubber, Vinyl, Vinyl-Asbestos.

Fed. Spec. SS-W-40A – Wallbase, Rubber, and Vinyl Plastic.

Fed. Spec. MMM-A-110B – Adhesive, Asphalt, Cut-back Type (for asphalt and vinyl asbestos tiles).

Fed. Spec DDD-C-0095A – Carpet and Rugs, Wool, Nylon, Acrylic, Modacrylic Polyester, Polypropylene.

RFCI (Resilient Floor Covering Institute) – Recommended Work Practices for the Removal of Resilient Floor Coverings.

MIA (Marble Institute of America, Inc.) - Dimensional Stone Design Manual III.

NFPA 101 – Life Safety Code.

TCA (Tile Council of America, Inc.) Handbook for Ceramic Tile Installation.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Installer shall a minimum than 5 years experience in the installation of flooring specialty of type required in project.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit product data including specifications, quality, color, and manufacturer installation instructions for each type of flooring to be installed as well as all accessories. Accessories include adhesives, mortar, grout, stair covering, vinyl base, etc.

For ceramic tile, submit shop drawings showing location of expansion joints.

For carpeting, submit shop drawings showing seaming diagrams indicating seams, areas of piecing, dimensions, directions of tufting, and locations of reducer strips and other accessories.

1.4.02 Certifications. For carpeting, prior to first delivery of carpet, submit certified copies of test reports, furnished by an independent testing laboratory, covering minimum requirements for flammability, static control, and tuft bind as specified. Accompanying the test reports, submit a certificate of compliance signed by an officer of the carpet manufacturer’s company stating that future deliveries of this quality carpet will conform to the specifications and test results as submitted

Submit a statement of compliance for materials.

Submit a testing laboratory certificate for test for fire hazard classifications. Date of test shall be within 2 years of date of submittal.

Submit, in triplicate, a notarized certificate addressed to the State Fire Marshal or other authority having jurisdiction over the project, stating that the resilient flooring has been installed as specified and as tested for fire hazard classification.

1.4.03 Samples. Submit 1 sample for carpeting and 3 samples for each type of ceramic and resilient tile showing the full range of color and pattern. Provide 1 sample for accessories such as reducer strips, vinyl base, etc.

1.5 DELIVERY, STORAGE AND HANDLING. Protect materials from damage during handling, delivery and storage at the job site.

Deliver flooring materials to project site in manufacturer's original unopened containers with manufacturer's name, brand name, grade, color, size, pattern, dye lot, and other pertinent information clearly marked thereon.

Store materials in their original containers at minimum temperature of 70 degrees F (21.1 degrees C) for at least 24 hours before installation.

For carpet, store materials up off the ground and cover completely to prevent intrusion of moisture and other damage.

Deliver dry-set and prepared Portland cement mortar and grout in sealed, moisture-proof containers.

Deliver latex mortar and grout additives and organic adhesives in sealed containers.

1.6 WARRANTY.

1.6.01 Carpeting. Warrant carpet to be free from undue wear (less than 10% during the warranty period), shrinkage, color irregularity, delamination, edge raveling, zippering at seams or failure to perform as specified herein, for a period of 3 years after completion of installation.

Warrant the carpet installation to be free from wrinkles, bubbles, puckering or other conditions due to faulty installation for a period of 2 years after completion of installation. During the warranty period, replace any carpet that does not provide an attractive appearance consistent with the above conditions.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Carpet and resilient tile installation shall not occur on a floor until after substantial completion of general construction. This means that the applicable areas, except for carpet, resilient tile, and vinyl base, are complete to the extent that the floor may be occupied or used by the Owner for the purpose for which it is intended.

Maintain ambient temperature and materials at approximately 70 degrees F (21.1 degrees C).

For ceramic tile, the ambient temperature shall be at least 50 degrees F (10.0 degrees C) and rising to build Portland cement setting beds, install leveling coats, and set and grout tile in Portland cement mortar. Comply with minimum temperature recommendations of manufacturers for bonding and grouting materials other than Portland cement.

2.2 PERFORMANCE AND BASIS OF DESIGN.

2.2.01 Carpeting. Provide first quality carpet tufted to produce the desired appearance, matching approved samples, free from blemishes and physical defects and meeting requirements of the specifications. Provide materials or treatment of carpet materials that are non-toxic in the form intended for ordinary carpet use, reasonably non-allergenic and free from other recognized health hazards. Provide carpet having no streaks, missing tufts, poorly dyed areas, or other manufacturing defects and that will not fuzz, bead or pill excessively.

2.3 ACCEPTABLE MANUFACTURERS.

2.3.01 Resilient Tile. Armstrong Floor Division, Azrock Floor Products, GAF Corporation, or approved equal.

2.3.02 Carpeting. Constantine Commercial Carpet, or approved equal.

2.4 MATERIALS.

2.4.01 Resilient Tile. Shall be vinyl composition tile, 12 x 12 inches (30.5 x 30.5 cm) by 1/8 inch (3.2 mm) thick, manufacturer, color and pattern as indicated in finish schedule. Tile shall comply with Fed Spec. SS-T-312B, Type IV, Composition 1 with minimum critical radiant flux of 0.45, when tested in accordance with ASTM E648. Tile shall be dimensionally stable, resistant to alkali, grease and oil, factory-waxed, uniform in thickness and cut with square edges. Color and pattern shall be uniform throughout entire thickness.

2.4.02 Resilient Tile Adhesive. Adhesive shall be alkali-resistant and moisture-resistant cut-back type asphaltic cement suitable for use on below-grade concrete subfloor, and shall conform to Fed. Spec. MMM-A-110A.

2.4.03 Resilient Stair Covering Materials. Coverings shall be rubber as manufactured by NORA Rubber Flooring. Adhesive for resilient stair covering shall be waterproof adhesive recommended by manufacturer. Caulking compound shall be epoxy type recommended by manufacturer.

One-piece molded pattern tread and risers shall meet Fed. Spec. RR-T-650, Composition A. Molded rubber, long nose style, 12 1/2 inches (31.8 cm) deep, 5/16 inch (7.9 mm) thick at front tapering to 3/16 inch (4.8 mm) at back, smooth surface, size required to fit indicated tread and riser dimensions.

Rubber tile shall be used as resilient covering for stair landings and other floor surfaces so indicated in stairwells. Rubber tile shall be 3/16 inch (4.8 mm) thick and in same color and pattern as selected for rubber treads.

2.4.04 Resilient Tile Accessory Materials. Transition accessories shall be vinyl as manufactured by the manufacturer of the resilient tile. Color shall be shown in finish schedule or to match surrounding. Adhesive shall be waterproof adhesive recommended by the manufacturer of the resilient tile.

Resilient base shall be vinyl as manufactured by the manufacturer of resilient tile flooring. It shall meet Fed. Spec. SS-W-40A, shall be 4 inches (10.2 mm) high and of topset cove style with premolded smooth top and cove, provided in as long lengths as practicable to suit conditions of installation. Color as indicated in the finish schedule. Adhesive for resilient base shall be waterproof adhesive recommended by the manufacturer of the base.

Concrete Slab Primer shall be non-staining type as recommended by flooring manufacturer.

Leveling and patching compounds shall be latex types as recommended by flooring manufacturer.

2.4.05 Ceramic Tile. Do not use tiles mounted in sheets with paper backing or other backing secured to tiles with water soluble adhesive.

Ceramic tile shall meet ANSI A137.1, standard grade as manufactured by a current member of the Tile Council of America or other approved manufacturer, color and pattern as indicated in the finish schedule.

Ceramic wall tile shall be glazed, impervious ceramic tile, cushion edge, 1/4 inch (6.4 mm) thick by 8 x 8 inch (20.3 x 20.3 cm) size, factory mounted on manufacturer's standard sheets in pattern with straight joints and color as indicated in finish schedule.

Provide coved internal corners, bullnose external corners and other trip shapes shown and required. Trim shall be same material and size as wall tile.

Base shall be the same material and size as wall, unless otherwise specified, straight.

Ceramic floor tile shall be ceramic mosaic tile, unglazed, impervious body, cushion edge, 1/4 inch (6.4 mm) thick by 1 x 1, 1 x 2, 2 x 2 inch (2.5 x 2.5, 2.5 x 5.1, 5.1 x 5.1 cm) nominal size, factory mounted on manufacturer's standard sheets in pattern with straight joints.

Colors shall be as indicated in finish schedule.

Floor tile for shower rooms, including top of curbs, shall be non-slip, containing 7% abrasive mixture.

2.4.06 Ceramic Tile Setting and Grouting Materials. Grout materials shall meet ANSI A118.6. Pigments for use in colored grouts shall be pure, lime proof and non-facing mineral pigments of the type recommended by the grout manufacturer. Water shall be clean and potable. Sand shall comply with ASTM C144 and ANSI A108.10, white where used in white mortar or grout.

Portland cement mortar and grout shall be as follows based on application and location:

Portland cement shall be ASTM C150, Type I, integrally waterproofed where used for floor and wall mortar beds in wet areas.

Hydrated lime shall be ASTM C206 or C207, Type S.

Portland cement grout shall be prepared non-shrinking grout, not field mixed and color as indicated in finish schedule.

Dry-Set Mortar shall be ANSI A118.1, of a color that will not show thru grout joints, and prepared under TCA formula 759 for ceramic wall tile.

Latex Portland cement mortar and grout shall be ANSI A118.4, using only latex additive and prepared mortars or grouts recommended by the manufacturers for use together and for compatibility.

Grout color for floors, walls and bases as indicated in finish schedule.

2.4.07 Organic Adhesives. Shall be ANSI A136.1, Type I or II as recommended by the manufacturer for type of tile and grout and type of installation being used. Organic adhesives used for wall setting of quarry and paver tile shall be a type that will not permit tile to slip.

2.4.08 Ceramic Tile Miscellaneous Materials. Cementitious backer unit shall be Modulars, Inc. “Wonder-Board”, United States Gypsum Co “Durock”, or as approved, 7/16 or 1/2 inch (11.1 or 12.7 mm) thick, 36 inches (91.4 cm) wide, in lengths to suit the application and minimize joints and shall comply with ANSI A118.9.

Waterproof membrane for thin-set installation shall be either Laticrete International, Inc. “Laticrete 301/335”, latex paste with a glass cloth reinforcing, or Noble Co. “Nobleseal TS”, 30 mil nominal CPE Elastomeric sheet laminated to spun-bond polyester.

Metal lath shall be cut from zinc coated steel sheets and weigh not less than 3/4 lbs per sq yd (0.41 kg per sq m), self-furring type.

Reinforcement shall be 2 x 2 inch (5.1 x 5.1 cm) 16/16 gauge (1.4 per 1.4 mm) welded wire fabric complying with ASTM A185.

Expansion joint filler shall be non-extruding type, width to match exposed expansion joint width.

Primer-sealer for gypsum plaster or gypsum wallboard shall be as recommended by the manufacturer or the organic adhesive used.

Latex underlayment shall be type intended for leveling minor depressions and imperfections in concrete floors and masonry walls.

2.4.09 Accessories. Duplex soap holder and rail shall be American Olean Tile Company #591 for thick setting beds or #594 for thin-set applications or as approved.

Marble thresholds shall be MIA group “A”, home finish, 3/4 inch (1.9 cm) thick, unless otherwise indicated. Furnish width and length as required to suit door opening, with beveled edges. Color as selected by Contractor.

Metal divider strips shall be white alloy zinc, 1/8 inch (3.2 mm) thick, heavy top type, depth as required, with suitable anchorage devices.

2.4.10 Carpet Accessories. Adhesive and edge sealers shall be water resistant, non-allergenic, non-flammable, non-toxic type as recommended by the carpet manufacturer for on-grade and above grade installations.

Reducer strips shall be preformed plastic equal to those manufactured by base manufacturer unless otherwise indicated. Acceptability of manufacturer shall be predicated in part on his ability to meet color requirements.
Colors are as indicated in finish schedule.

2.5 MANUFACTURE AND FABRICATION.

2.5.01 Carpet Construction. Yarn material for CPT-01 shall be 100% BASF Zeftron Nylon and for CPT-02 shall be 100% Ultron VIP type 6,6 nylon.

Texture and style for CPT-01 shall be loop and for CPT-02 shall be tip sheared loop.

Tufts per square inch (6.5 sq cm) for CPT-01 shall be 160 and for CPT-02 shall be 112.

Pile height for CPT-01 and CPT-02 shall be 0.2

Yarn face weight for CPT-01 shall be 41 oz., and for CPT-02 shall be 33 oz.

Backing system for CPT-01 and CPT-02 shall be Woven ActionBac.

Widths for CPT-01 and CPT-02 shall be 12 feet.

Carpet dye lots and runs shall be in sequence and clearly identified.

PART 3 – EXECUTION

3.1 INSPECTION.

3.1.01 Resilient Floor and Carpet.

Verify dimensions in the field and supplement or modify the approved shop drawing layout dimensions as required. Report to the Contractor in writing changes from what is shown on the approved drawings and obtain direction before proceeding with the work.

Verify that concrete subfloors are level within 1/4 inch in 10 feet (6.4 mm in 3.0 m) as determined by a 10 foot (3.0 m) straight edge placed anywhere on the surface in any direction, are troweled smooth and level, and will be visibly dry and clean and otherwise acceptable to the applicator before commencing the work.

Perform bond and moisture tests on concrete subfloors to determine if surfaces are sufficiently cured and dry as well as to ascertain presence of curing compounds. Verify that they are acceptable for installation of adhesive and resilient tile or carpeting as determined by manufacturer's moisture testing procedures for concrete slabs.

Do not allow resilient flooring or carpeting work to proceed until subfloor surfaces are satisfactory.

3.1.02 Ceramic Tile. Examine substrates, areas and conditions where tile will be installed with installer present. Check for compliance with tile and tile-setting material manufacturers' written requirements for installation tolerances and other conditions affecting performance of installed tile.

Verify that substrates for setting tile are firm, visibly dry, clean, free from oil, waxy films and curing compounds. Verify substrates are within flatness tolerances required by referenced ANSI A108 series of tile installation standards for installations indicated.

Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work and similar items located in or behind tile has been completed before installing tile.

Verify that joints and cracks in tile substrates are coordinated with tile joint locations. If not coordinated, adjust latter in consultation with Engineer.

To preclude an unacceptable level of moisture in or being emitted from substrates, verify that substrate is acceptable for installation of setting bed and tile as determined by respective manufacturer's moisture testing procedure for concrete slabs, or other substrates.

Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION.

3.2.01 Resilient Tile and Carpeting. Use leveling and patching compounds as recommended by resilient flooring manufacturer for filling small cracks, holes and depressions in subfloors.

Remove coatings from subfloor surfaces that would prevent adhesive bond or be detrimental to the proper installation of carpeting including curing compounds, paint, oils, waxes and sealers. Follow manufacturer's instructions.

Thoroughly clean floor to remove foreign materials and inspect subfloor.

Apply concrete slab primer, if recommended by flooring manufacturer, prior to application of adhesive or installation of carpet. Apply in compliance with manufacturer's directions.

3.2.02 Ceramic Tile. Remove coatings, including curing compounds, and other substances that contain soap, wax, oil or silicone and are incompatible with tile-setting materials by using a terrazzo or concrete grinder, a drum sander or a polishing machine equipped with a heavy-duty wire brush.

Provide concrete substrates for tile floors installed with dry-set or latex-Portland cement mortars that comply with flatness tolerances specified in referenced ANSI A108 series of tile installation standards for installations indicated.

Use trowelable leveling and patching compounds per tile-setting material manufacturer's written instructions to fill cracks, holes and depressions.

Remove protrusions, bumps and ridges by sanding or grinding.

For tile exhibiting color variations within the ranges selected during sample submittals, verify that tile has been blended in the factory and packaged so tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, either return to manufacturer or blend tiles at project site before installing.

Protect the work and adjacent construction against damage during process of the work until completion.

3.3 INSTALLATION.

3.3.01 Resilient Tile. Install materials in accordance with the manufacturer's printed directions, unless otherwise specified.

Lay tile from the contents of at least two different containers so that the color, or pattern will be uniform and not spotty, as caused by the variances sometimes found in the different containers. If necessary, sort the tile from different containers to provide uniform appearance in the area being laid. Spotty work will be cause for rejection of the work.

Lay tile so as to insure good contact with floor, with close even joints and with finished surfaces in true and smooth plane.

Lay tiles square with room axis and with pattern or grain in one direction, unless otherwise required. Tile at walls shall be not less than half full size.

Fit tile neatly against wall at base, into breaks and recesses and around pipes and other penetrations. Cut, fit and scribe as required by field conditions.

3.3.02 Flooring Transition Accessories. For resilient edge strips (reducers), provide resilient edge strips where floor covering terminates exposing the edge of the covering. Center under door where floor covering terminates at a door opening.

Fit resilient materials to finish flush with abutting flooring and against flooring and other abutting materials, with no joint greater than 1/64 inch (0.40 mm). Scribe to configuration of door frames and other abutting construction.

Bond resilient materials securely to substrate in full bed of adhesive.

3.3.03 Resilient Base. Cut base material into accurate lengths as required for minimum number of joints. Match edges at all seams or double-cut adjoining lengths.

Bond base to substrates in full bed of adhesive. Install with tight butt joints with no joint widths greater than 1/64 inch (0.40 mm). Press down so that bottom cove edge follows floor profile. Top and bottom edges shall have firm contact with floor and wall surfaces.

Form internal corners by mitering. Form external corners by coping and bending material sufficient length around corner for anchorage.

Scribe base accurately to abutting materials.

3.3.04 Resilient Stair Covering. Install resilient materials securely to substrates in full bed of adhesive. For treads, fit integral nosing and cut back edge to profile of stair. Fill with caulking compound the open space at nosing between stair and resilient tread.

On landings, allow rubber tile material to flatten prior to installation. Fit material to finish flush with tread and against riser and other abutting materials with no joint width greater than 1/64 inch (0.40 mm). Match grain and color between adjacent pieces.

3.3.05 Ceramic Tile. Preferred order of work where applicable is installation of base and walls followed by floors.

When fitting tile, cut and drill tile for proper fitting around equipment in place without damaging work. Rub down the exposed sharp edges of cuts with an abrasive stone. Grind and fit carefully at intersections, against trim, finish, and built-in items. Fit tile closely around outlets, pipes, fixtures and fittings, so plates, collars and escutcheons will overlap cuts.

Set tile in a pattern indicated as factory mounted in sheets. Grout joints in ceramic tile with latex Portland cement grout. Grout joint shall be consistent and no wider than 1/8 inch (3.2 mm).

Mix and use proprietary or trade marked setting and grouting materials in strict accordance with manufacturer’s instructions, unless otherwise specified.
When laying out walls, where possible, lay out work so that no tile less than half size occurs. Unless tile work is required to fill vertical spaces exactly, maintain heights indicated in full courses to produce nearest attainable heights without cutting.

When laying out floors, center field work in both directions to permit laying pattern with minimum of cut tiles. Lay floor without borders from center lines outwards. Make necessary adjustments at walls.

Set wall and base tile firmly in bond coat, with joints at jambs, returns and the like level and true with joints in main field. Align vertical joints with joints in floor wherever possible. Set tile with joints straight, level, perpendicular and of even width not to exceed 1/16 inch (1.6 mm) for ceramic tile.

When setting floor tile where an area is over 100 square feet (9.3 sq m), lay the tiles or sheets of tile to a straight edge. Reset straight edge at suitable intervals. Take care in setting tile so that all units and joints are straight and that they intersect uniformly with the units and joints running in the opposite direction. Set tile with joints perpendicular, parallel with room axis, and of even width not exceeding 1/16 inch (1.6 mm) for ceramic tile.

For expansion joints, form expansion joints thru mortar leveling and setting beds, bond coats or adhesive and tile with joint filler and removable wood strips over all control and construction joints in horizontal or vertical surface. Form expansion joints where backing materials change and where tile work abuts restraining surfaces such as perimeter walls, curbs, columns and pipes, and elsewhere as indicated. Form expansion joints in ceramic tile to match width of grout joints in tile field.

Clean tile in accordance with grout manufacturer's instructions and applicable reference specification.

Wet cure walls in wet areas and floors in all areas a minimum of 72 hours in accordance with grout manufacturer's instructions. Cover with polyethylene film as required to keep surfaces constantly damp during curing.

3.3.06 <u>Ceramic Tile Installation on Walls and Bases</u>.

Walls and bases in wet areas on metal studs: Secure membrane of #15 asphalt-impregnated felt or 4 mil (0.10 mm) polyethylene film to metal studs.

Fasten cementitious backer unit to metal studs in accordance with ANSI 108.11, with joints fitted closely, filled solid with latex mortar and taped with glass fiber tape embedded in and covered with latex mortar. Properly support backer unit at cut-outs.

Apply a skim coat of latex mortar, minimum of 1/16 inch (1.6 mm) thick over entire surface and allow to harden.

Set tile on skim coat in a bond coat of dry-set mortar or latex Portland cement mortar in compliance with ANSI A108.5 and mortar manufacturer's instructions.

Walls and bases in wet areas on gypsum wallboard (or gypsum plaster): Apply membrane of #15 asphalt-impregnated felt or 4 mil (0.10 mm) polyethylene film over surface of gypsum wallboard (or plaster).

Apply a layer of metal lath, securing to studs and to gypsum board (or plaster). Cut lath at control joints.

Set tile on fresh mortar bed in a bond coat of neat Portland cement in a bond coat of dry-set mortar or latex Portland cement mortar in compliance with ANSI A108.1.

Walls and bases in dry areas on gypsum wallboard (or gypsum plaster): Prime surface and all cut edges and penetrations of substrate in accordance with adhesive manufacturer's instructions.

Seal all openings at edges of substrate and holes around penetrating elements with non-hardening sealant in accordance with adhesive manufacturer's instructions.

Set tile on organic adhesive of a type recommended by the manufacturer for the type of tile and grout being used. Apply adhesive with a notched trowel as recommended by the manufacturer. Set tile in compliance with ANSI A108.4 and adhesive manufacturer's instructions.

Walls and bases on masonry (or cement plaster): Where wall substrate irregularities exceed 1/4 inch in 8 feet (6.4 mm in 2.6 m) or where walls need to be thickened to provide proper spacing for tile returns, etc., apply a leveling bed. Clean and roughen wall surface as required to thoroughly bond leveling bed.

For leveling beds less than 1/4 inch (6.4 mm) thick, provide dry-set mortar, latex underlayment or latex Portland cement mortar of the type intended for impervious tile.

For leveling beds from 1/4 to 1 inch (0.64 to 2.5 cm) thick provide mix composed of 1 part Portland cement, 1/2 to 1 part hydrated lime and 5 to 7 parts damp sand by volume.

Apply mortar to required thickness and carefully screed surface to true, accurate plane. Cure under vapor proof membrane or other approved method for not less than 3 days before installing tile.

Set tile in a bond coat of dry-set mortar or latex Portland cement mortar in compliance with ANSI A108.5 and mortar manufacturer's instructions.

3.3.07 Ceramic Tile Installation on Floors.

Floors in wet areas: Prepare base slab and install setting bed accurately to slopes indicated and in accordance with ANSI A108.1.

Maximum variation from required plane shall be 1/8 inch in 10 feet (3.2 mm in 3 m).

Reinforce setting bed with reinforcing mesh in center of setting bed thickness.

Install waterproof membrane over setting bed (wet cured 3 days minimum) in accordance with manufacturer's instructions.

Set tile on waterproof membrane in a bond coat of latex Portland cement mortar in compliance with ANSI A108.5 and mortar manufacturer's instructions.

Floors in dry areas: Slab preparation for thin-set installation.

Clean, etch, or scarify slab as required to secure proper bond for tile installation.

Fill depressions in slab with latex underlayment or latex Portland cement mortar.

Set tile on fresh mortar bed in a bond coat of neat Portland cement paste in compliance with ANSI A108.1.

Set tile on cured mortar bed (wet cured 3 days minimum) or on concrete base slab in a bond coat of latex Portland cement mortar in compliance with ANSI A108.5 and mortar manufacturer's instructions.

3.3.08 Accessory Installation. Install a duplex soap holder and rail for each shower head in shower rooms. Anchor securely to wall.

Set marble thresholds firmly into bond coat, level and true in both directions.

Provide metal divider strips at juncture of ceramic mosaic tile floors and other floors where thresholds are not indicated. Set divider strips level, straight and true, at proper heights, and bonded to substrate with adhesive recommended by manufacturer.

3.3.09 Carpeting. Install materials in strict accordance with the manufacturer's printed instructions, except where higher standards are required, direct to concrete floors, using application techniques recommended by the adhesive manufacturer.

Do not install carpet where or when there is excessive moisture present. Condition building area carpet and adhesives as recommended by the respective manufacturer.

Perform necessary cutting on the job site. Unroll carpet face up and cut the lengths required.

Install carpet flat and smooth, without bulges, ridges or wrinkles. Lay work true, even, with tight joints, surfaces flush and set firmly against thresholds and divider strips. Scribe carpeting to within 1/16 inch (1.6 mm) of obstructions.

Cut, fit and scribe carpet edges snugly and evenly along the entire length of abutting vertical surfaces. Stop carpeting at vertical surfaces without the use of trim pieces or moldings. Check starting wall for squareness and allow for off-square walls.

“Dry-cut” vertical obstructions such as columns and pipes with as much overlap as possible. After the carpet is cemented in place, “finish-cut” these areas, being careful to position the seams made by these cuts before working the balance of the carpet into place.

Lay carpet with the rows of yarn parallel and running in the same direction throughout, except as otherwise approved by the Engineer. Side to end of cross seaming will not be approved.

Install carpeting in dye lot and run sequence, matching color and pile height at the juncture of all roll breadths.

Keep carpet joints to a minimum using pieces as large as possible.

Locate seams occurring at doors and parallel to doors centered under the door.

Extend carpet into closets, alcoves and recesses.

Prepare seams by trimming off the factory edge on the carpet, far enough into the carpet so that a clean and even seaming edge is provided, using cutting tools having razor sharp blades.

Treat cut edges or seaming with a seam sealer using a product recommended by the carpet manufacturer. Apply sealer to the edge of the carpet, at the level of the backing material, to form a secure bond when the two pieces of the carpet are jointed together. Remove any excess sealer on the face of the carpet immediately with the proper solvent.

Securely bond seams and cut edges to the subfloor along their entire length. Carefully mark the first seam on the floor, straight and true. Cut and fit carpet before cement is applied, using the first seam mark as a guide. Overlap breadths 1/8 inch to 1/4 inch (3.2 to 6.4 mm) and check junctures for differences in shading and pile height.

Turn back breadths halfway and apply part two of the carpet adhesive with a trowel with notches sized as recommended by adhesive manufacturer. After the first breadth is unrolled and adjusted to the seam line, tuck the overlapped width into place to make a tight fit. Eliminate any puckering or peaking from excess width by distributing the excess toward the center of the breadth with the knee kicker. Close any opened areas by bringing sufficient width from the center with a series of knee kicks. Take care that the knee kicker does not tear the carpet backing.

Sweep trapped air toward the edges, using a stiff push broom and not a linoleum roller. Check seams for evenness of pile height and adjust unevenness by an underlayment of felt paper and double-sided pressure-sensitive carpet tape. Raise pile trapped in seams with a knife point or other suitable instrument.

3.3.10 Protection. Do not allow foot traffic on work on or at perimeter of new tile work until new adhesives and grout have set, dried and cured. For carpeting, do not allow traffic for at least 24 hours. For ceramic tile, do not allow traffic or work for 7 days.

Cover finished floors until all construction is complete.

For ceramic tile, protect waterproof membrane and lead flashings at floor drains.

3.3.11 Cleaning. After installation in an area is complete, remove waste and excess materials, tools and equipment, dirt and debris from the building.

For carpeting, carefully and thoroughly vacuum clean the entire floor surface with an upright, beater bar type vacuum cleaner and clean soiled areas of carpeting.

For tile work, once tile has been sufficiently seated, (7 days for ceramic tile), clean surfaces free of adhesive, dirt and other foreign materials in accordance with the instructions of the tile manufacturer.

Replace flooring that cannot be cleaned satisfactorily for acceptance by the Owner.

3.4 SPARE STOCK. For resilient tile, provide one carton of tile for each 1,000 square feet (93.0 sq m) of flooring installed. For ceramic tile, provide one square foot of tile for each 1,000 square feet (93.0 sq m) of installed flooring tiles.

End of Section

SECTION 09510

ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SCOPE. This section covers lay-in acoustical panel ceilings with exposed grid suspension systems to be furnished and installed at the locations indicated on the drawings.

1.2 GENERAL.

1.2.01 Governing Standards.

AM (Acoustical Materials) MA-1-II - Ceiling Sound Transmission Test by Two-Room Method.

ASTM (American Society for Testing and Materials) C423 – Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

ASTM C635 - Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

ASTM C636 – Specification for Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

ASTM C665 - Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.

ASTM E1264 – Specification for Classification for Acoustical Ceiling Products.

CISCA – Ceilings and Interior Systems Construction Association.

National Fire Protection Association (NFPA) 90A – Installation of Air Conditioning and Ventilating Systems.

1.3 QUALITY ASSURANCE.

1.3.1 Contractor's Qualifications. Contractor shall be authorized by manufacturer with a minimum of 5 years experience.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit Shop Drawings that show layout of ceiling suspension system(s) to be installed, pattern, mechanical fixtures, and other items that will penetrate the ceiling system. Submit large scale isometric detail showing method of suspension, support fastening devices, tying, carrying members, main runners cross runners, wall molding, accessibility, special framing and bracing methods for items supported by the system. Also show large scale cross section drawings detailing light fixtures, air diffusers, grilles, sprinkler heads and other items that penetrate the ceiling system.

1.4.02 Certifications. Submit in triplicate a certificate addressed to the Fire Marshall or other authority having jurisdiction over the Project in the following suggested format with bracketed questions completed:

> "This is to certify that, (name of product) which was or will be furnished to (company making application of product) for (job or Project name and address) is the same in all respects in content, and specifications for mixing and/or application as the specimen tested by (name of laboratory) on their project or test number (test number) dated (date of test).
>
> Flame spread is (flame spread test result number).
>
> Smoke developed is (smoke test result number developed)."

Also, submit a certificate addressed to the Fire Marshall or other authority having jurisdiction over the Project from the company that installed the product, stating that the product was installed as tested.

Submit a testing laboratory certificate from an independent and nationally recognized testing laboratory identifying tests for fire hazard classification dated within 2 years of date of submittal. Test report, in duplicate, for fire resistance rating, showing construction details of test panel. One copy will be returned for use by the Contractor.

Also submit certificate of compliance stating that materials and installation comply with the Contract Documents.

1.4.03 Samples. Submit full size samples for each type of acoustical units, as specified in finish schedule and grid system components. Full size sections shall be approximately 12 inches (30.48 cm) long.

1.4.04 Test Reports. Submit test data for suspension members as outlined in ASTM C635 and performed by an approved independent testing laboratory. Submit data in log form as outlined in C635, Article 10. Submit shear and pull-out test data for hanger devices to be used.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver materials in their original packages, containers or bundles with manufacturer's name, brand name, grade and other pertinent data clearly marked.

Store materials in original containers in dry area at not less than 65 degrees F (18.33 degrees C) for at least 24 hours before installation.

1.6 WARRANTY. Warrant the Work for 2 years against defective materials and workmanship, including shrinkage of acoustical units and discoloration, except where such failure is due to abuse or failure of related work installed by other parties.

During the warranty period, restore defective Work to the standard of the Contract Documents, including materials, labor, refinishing and other costs incidental to the Work. Inspect the Work within 24 hours after receipt of notice from the Engineer. Restore Work found to be defective as defined in the Contract Documents within 10 days after receipt of notice from the Engineer.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Prior to start of the Work, maintain the spaces to receive the work at minimum temperature of 65 degrees F (18.33 degrees C).

Install acoustical materials only when normal temperature and humidity conditions approximate the interior conditions that will exist when the building is occupied. Maintain these conditions during and after the installation.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Minimum performance requirements for completed acoustical ceiling installations as tested by an approved independent testing laboratory:

Noise reduction coefficient (NRC) range shall be as specified, when tested in accordance with ASTM C423, mounting no. 7 suspension system. Ceiling sound transmission class (STC) shall be as specified, when tested in accordance with AMA-1-II with interrupted ceiling detail at partitions.

Light reflectance coefficient shall be a minimum 0.90 per ASTM E1264.

Fire hazard classification shall be a maximum of 25 for flame spread and 50 for smoke developed, when tested in accordance with ASTM E84.

2.2.01 Plenum Chamber. When the space above the suspended ceiling system is used as an air plenum and the ceiling system is not a required part of a UL-fire-rated assembly, provide members of the ceiling system which meet the requirements of NFPA 90A.

2.2.02 Suspension System Members. Support all applied dead loads without exceeding a deflection of 1/360 of the unsupported span.

2.3 ACCEPTABLE MANUFACTURERS.

2.3.01 Suspension System. Chicago Metallic, Donn Corporation, or equal.

2.3.02 Acoustical Ceiling Units. Armstrong Cork Company, Celotex Corporation, Conwed Corporation, U.S. Gypsum Company, or equal.

2.4 MATERIALS.

2.4.01 Suspension System Members. Fabricate members and devices from materials and conform to design criteria for intermediate-duty systems, as specified in ASTM C635 and as modified in this Section.

For hanger attachment devices, provide anchors, fasteners, hooks, eyebolts and other devices designed for fastening to building construction, for support of ceiling suspension systems, and for maximum loads that may be transmitted by the completed ceiling system. Furnish devices that are to be set in concrete complete with approved placement and location drawings.

Hanger wire shall be galvanized carbon steel, soft temper, prestretched, with a yield stress load of at least 3 times design load, but not less than 12 gage (2.8 mm).

Carrying, hanging and bracing channels shall be 11/2 inch (3.81 cm) cold rolled steel, galvanized, having a minimum weight of 0.475 lbs per lineal foot (0.711 kg per m), unless otherwise indicated.

Tie wire shall be not less than 18 gage (1.3 mm) soft temper galvanized steel. Specially designed spring wire and sheet steel clips may be used providing they meet the standards specified.

2.4.02 Wall Molding. Shall be angle or channel shaped; unless indicated otherwise, exposed flange of same width as main runners; factory finished to match main runners.

Provide special shadow line wall molding as indicated.

2.4.03 Acoustical Tiles. Shall be mineral tile of homogeneous mineral fiber, blended and cast with cementitious binder and manufactured by Armstrong World Industries, Inc. “Cirrus”; USG Interiors, Inc. “Eclipse”; or approved equal.

Tile size shall be of 24” x 24” (61.0 cm x 61.0 cm) , thickness shall be 3/4 inch (1.9 cm), edge treatment shall be ‘shadowline’, NRC range shall be 0.65 - 0.75. Thermal resistance (R-value) shall meet or exceed 2.12, face pattern shall be monolithic texture and the finish shall be factory applied vinyl latex paint with white.

2.4.04 Sound Attenuation Blanket. Shall be 2 inch (5.1 cm) thick glass or mineral fiber complying with ASTM C665, Type I, 2.5 pcf (40.1 kg per cu m) density.

2.4.05 Acoustical Sealant. Shall comply with acoustical ceiling system manufacturer’s instructions.

2.4.06 Acoustical Ceiling Systems. Provide acoustical ceilings consisting of ceiling suspension systems and acoustical elements, as indicated and specified.

2.4.07 Exposed Grid Lay-In System. Factory-finished exposed main runners and cross runners directly suspended from overhead construction shall be mechanically interlocked. Acoustical lay-in panels (boards) shall be sized for laying in the grid openings and supported by the exposed flanges of the grid members. Exposed angle or channel molding shall be used to support panels at wall line.

In ceilings which form an air plenum and where indicated, hold panels in place with clips.

In systems using panels with regressed edges, provide shims for support of runners at wall molding where panel edges are cut square.

PART 3 - EXECUTION

3.1 PREPARATION. Protect this Work and adjacent construction against damage during progress of the Work until completion of the Project.
Coordinate with the other work supported by or penetrating through ceilings, including light fixtures, HVAC equipment and partition systems.

3.2 INSTALLATION. Install acoustical ceiling systems, in conformance with ASTM C636, modifications included in this Section, approved Shop Drawings, material samples and printed information from material manufacturer.

3.2.01 Suspension System. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane adjacent members.

Do not attach to or suspend (support) from metal roof deck any part of ceiling suspension system.

Where overhead construction will not permit attachment to or the proper location of hanging devices, provide additional support steel in the form of specified carrying channels or other steel members of size required to safely support the completed ceiling system.

Install entire ceiling system so additional bracing is not required to support movable partitions at any point.

3.2.02 Acoustical Units. Install acoustical units in strict conformance with manufacturer's approved printed installation instructions and this Section.

Install sound attenuation blanket over ceilings indicated to be sound attenuated.

Seal joints between wall or partition and wall molding for ceilings indicated to be sound attenuated with acoustical sealant.

In all locations where edges of acoustical units are exposed and at intersection of acoustical units with all vertical surfaces, provide wall molding. Rest ends of runners on extended leg of wall molding and wire-tie or clip the runners to the wall molding.

Provide all framing in acoustical ceilings for support of lighting fixtures, grilles, and other penetrating features as indicated and as required to complete the installation. Coordinate the Work with that of mechanical and electrical work.

Locate acoustical units in a straight pattern with border units not less than 1/2 unit in width. Center joints or center line of units on lighting fixtures or other penetrations. Locate units accurately with joints parallel with room axis, and in line, in both directions.

3.2.03 Cutting and Fitting.

Do all cutting and fitting of acoustical materials as required to complete the Work and to accommodate the work of other trades.

Where cut edges of lay-in tile or boards with edge treatment other than square occur at wall molding, rout the edges to match the edge treatment.

3.2.04 Adjusting. Remove and replace acoustical units that are defective, or that have been damaged for any reason, with new matching acoustical units.

Repaint acoustical metal pan units that have been scratched, marred or have otherwise damaged surfaces to match adjacent units, or replace them with new matching units, as approved.

3.2.05 Cleaning. Following completion of Work, clean dirty or discolored acoustical units and leave surfaces free from any foreign matter.

End of Section

SECTION 09720

WALL COVERINGS

PART 1 – GENERAL

1.1 SCOPE. This section includes surface preparation, prime painting, and vinyl coated fabric wall covering.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) D4442 - Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

ASTM F793 – Specification for Classification of Wallcovering by Durability Characteristics.

FS L-P-1040 – Specification for Plastic Sheets and Strips (Polyvinyl Fluoride).

NFPA (National Fire Protection Association) 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. Company shall specialize in manufacturing products specified in this section with a minimum of 5 years documented experience.

1.3.02 Installer Qualifications. Company shall specialize in performing Work of this section with a minimum of 5 years documented experience.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Shop drawings shall indicate wall elevations with seaming layout. Submit product data on covering and adhesive.

Submit manufacturer's installation instructions, special procedures, and any perimeter conditions requiring special attention.
Submit data on cleaning, touch-up, and repair of covered surfaces.

1.4.02 Samples. Submit 3 samples of covering 12 x 12 inch (30.5 x 30.5 cm) in size illustrating color, finish, and texture.

1.4.03 Test Reports. Test reports shall indicate verification of flame and smoke ratings tested by UL or an agency approved by authority having jurisdiction.

1.4.04 Mock-Up. Provide panel, 8 feet (2.4 m) wide, and full height, that illustrates installed covering, and joint seaming technique. Locate where directed by Engineer. Mock-up may remain as part of the work.

1.4.05 Extra Materials. Supply 25 linear feet (7.62 linear m) of each color and pattern of covering; store where directed by Engineer.

Package and label each roll by manufacturer, color and pattern, and destination room number.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver wall paper rolls in their original packaging with manufacturer’s name, brand names, grade, lot, etc. clearly marked. Inspect roll materials on site to verify acceptance. Protect packaged adhesive from temperature cycling and cold temperatures. Do not store roll goods on end.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or vinyl covering product manufacturer.

Maintain temperatures within manufacturer approved range 24 hours before, during, and after installation of adhesive and covering.

Provide lighting level of 80 ft candles measured mid-height at substrate surfaces.

2.2 PERFORMANCE REQUIREMENTS AND BASIS OF DESIGN. Wall coverings shall conform to flame and smoke ratings of 25/50 when tested to ASTM E84.

2.3 ACCEPTABLE MANUFACTURERS. Columbus Coated Fabrics, GenCorp Wall Coverings, Koroseal Wall Coverings, Vicrtex Wall Coverings or approved equal.

2.4 MATERIALS. Wall covering shall be vinyl coated fabric roll stock and shall comply with ASTM F793. Include clear top overcoat of polyvinyl fluoride in accordance with FS L-P-1040 Type 1, Grade B, Class 2, 0.0005 inch (0.01 mm) thick.

Adhesive shall be type recommended by covering manufacturer to suit application to substrate.

Termination trim shall be extruded plastic.

Substrate filler shall be as recommended by adhesive and covering manufacturers.

Substrate primer and sealer shall be alkyd enamel.

PART 3 – EXECUTION

3.1 INSPECTION. Verify that substrate surfaces are prime painted and ready to receive work, and conform to requirements of the covering manufacturer.

Measure moisture content of surfaces using an electronic moisture meter. Do not apply coverings unless moisture content of surfaces is below the following maximums:

> Plaster and Gypsum Wallboard: shall be less than 12 percent.
>
> Masonry, Concrete, and Concrete Unit Masonry: shall be less than12 percent.
>
> Wood Surfaces: shall be less than 15 percent, measured in accordance with ASTM D4442.

Verify flatness tolerance of surfaces does not vary more than 1/8 inch in 10 feet (3 mm in 3 m) nor vary at a rate greater than 1/16 inch per ft (1.5 mm per 300 mm).

3.2 PREPARATION.

Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing. Wash impervious surfaces with tetra-sodium tri-sodium phosphate, rinse, neutralize and wipe dry. Correct defects and clean surfaces, which affect work of this section. Remove existing coatings that exhibit loose surface defects. Fill cracks in substrate, smooth irregularities with fillers, and sand to a smooth finish. Seal marks with shellac, which may bleed through surface finishes. Apply one coat of primer sealer to substrate surfaces. Lightly sand smooth surface once allowed to dry. Vacuum clean surfaces free of loose particles.

3.3 INSTALLATION. Apply adhesive to wall covering surface immediately prior to application of covering. Let contact adhesive set tack free. Use each roll in appropriate number of sequences to match pattern. Razor trim edges on flat work table, changing blade often to prevent rough cut edges. Do not razor cut on gypsum board surfaces. Apply covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface. Butt edges tight. Horizontal seams are not acceptable. Do not seam within 2 inches (5.1 cm) of internal corners or within 6 inches (15.2 cm) of external corners. Install covering before installation of bases, cabinets, hardware, or items attached to or spaced slightly from wall surface. Do not install covering more than 1/4 inch (6.4 mm) below top of resilient base. Cover spaces above and below windows, above doors, in pattern sequence from roll. Apply covering to electrical, telephone and wall plates prior to replacing.

Covering is required behind radiation and convector covers.

Where covering tucks into reveals, metal wallboard or plaster stops, apply covering with contact adhesive within 6 inches (15.2 cm) of covering termination. Ensure full contact bond. Install termination trim. Remove excess adhesive while wet from seam before proceeding to next covering sheet. Wipe clean with dry cloth.

3.4 CLEANING. Clean coverings of excess adhesive, dust, dirt, and other contaminants. Reinstall wall plates and accessories removed prior to work of this section.

End of Section

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 SCOPE. Painting of all equipment, pipe, ducts, conduits, accessories and appurtenances is included in this section. Furnish all materials, equipment and labor for painting to include surface preparation, prime coats and topcoats as specified.

Coatings for exterior work shall include exterior epoxy gloss enamel and exterior epoxy semi-gloss enamel.

Coatings for Interior work shall include overhead, self-priming, one-coat epoxy flat finish (spray-applied), alkyd eggshell enamel, alkyd semi-gloss enamel, epoxy semi-gloss enamel, epoxy gloss enamel, and epoxy eggshell enamel.

1.2 GENERAL. The term paint shall mean both paints and coatings including emulsions, enamels, stains, varnishes, sealers, and all other coatings whether organic or inorganic and whether used as prime, intermediate, or finish coats.

The Contractor shall purchase paint from an approved manufacturer. The manufacturer shall assign a representative to inspect the application of the product both in the shop and field. The manufacturer's representative shall submit a report to the Engineer at the completion of the work, identifying the products used and verifying that said products were properly applied and that the paint systems were proper for the exposure and service.

All new buildings, facilities, structures, and appurtenances, which are customarily painted, shall be painted with not less than 1 shop coat and 2 field coats, or 1 prime coat and 2 finish coats of the appropriate paint. Surfaces of exposed members that will be inaccessible after erection shall be cleaned and painted before erection.

Aluminum, stainless steel, fiberglass, and bronze work shall not be painted unless color coding and marking is required or otherwise specified.

Unless otherwise required or specified, do not paint factory-finished or installer-finished items such as metal toilet enclosures, prefinished partition systems, acoustic materials, architectural woodwork and casework, elevator entrance doors and frames, elevator equipment, and finished mechanical and electrical equipment, including control, light fixtures, switchgear and distribution cabinets.

Unless otherwise indicated or specified, do not paint surfaces in concealed areas and generally inaccessible areas, foundation spaces, furred areas, utility tunnels, pipe spaces, duct shafts and elevator shafts.

Unless otherwise indicated or specified, do not paint moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts.

Paints and the paint products mentioned in this specification are given as standards of quality. Products of other manufacturers, comparable in quality and type to those specified will be acceptable if the manufacturer provides, in writing, satisfactory proof and data on past performance of similar applications in water and wastewater treatment plants.

Contractor shall be responsible for abatement and disposal, by suitable means and methods, for all hazardous substances before applying any coatings.

1.2.01 Governing Standards.

American Society for Testing and Materials (ASTM) D16 – Standard Terminology for Paint, Related Coatings, Materials and Applications.

Society for Protective Coating SSPC-SP 1 - Solvent Cleaning.

SSPC-SP 3 - Power Tool Cleaning.

SSPC-SP 6 - Commercial Blast Cleaning.

SSPC-SP 7 - Brush-Off Blast Cleaning.

SSPC-SP 10 - Near-White Blast Cleaning.

1.3 QUALITY ASSURANCE. Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

Review other Master Specification Sections in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

All materials shall be brought to the jobsite in the original sealed and labeled containers and shall be subject to inspection by the Engineer.

Conform to applicable code for flame/fuel/smoke rating requirements for finishes.

1.3.01 Manufacturer's Qualifications. The product manufacturer shall be a company specializing in manufacturing quality paint and finish products with 5 years documented experience.

1.3.02 Contractor's Qualifications. The applicator shall be a company specializing in commercial painting and finishing with 5 years of documented experience.

1.3.03 Testing. Wet film thickness readings or spreading rate checks shall be made by the Contractor for each 500 square feet (46.5 sq m) of painted surface to make certain that proper film thickness is being achieved. More frequent checks may be required by the Contractor at his discretion.

Films exhibiting defects shall be entirely removed and the surface recoated at no additional cost to the Owner.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit product data, including paint label analysis and application instructions for each material proposed for use including all finishing products and special coatings. Submit Material Safety Data Sheets (MSDS). Manufacturers of equipment to receive finish coating in the shop shall submit color charts with the shop drawings for color selection by the Engineer.

1.4.02 Certification. The manufacturer shall provide certification that all paints, primers and thinners which may come into contact with potable water meet the National Sanitation Foundation Standard 61 and all MDCH and MDEQ regulations in force at the time of submittals.

1.4.03 Samples. Submit 3 each 8 x 10 inch (20.3 c 25.4 cm) samples indicating textures for each scheduled finish surface.

1.4.04 Extra Stock. Provide a 1 gallon container of each color and surface texture to Engineer and store as directed by Engineer. Label each container with color, texture, date, room locations, and surface preparation in addition to the manufacturer's label.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver products to site in original, new and unopened labeled packages and containers.

Container labeling shall include manufacturer's name, stock number, date of manufacture, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation, contents by volume, for major pigments and vehicle constituents, thinning instructions, and instructions for mixing.

Store paint materials at minimum ambient temperature of 45 degrees F (7.2 degrees C) and a maximum of 90 degrees F (32 degrees C), in well ventilated area, unless required otherwise by manufacturer's instructions.

Take precautionary measures to prevent fire hazards and spontaneous combustion.

Oily or solvent-soaked rags and all waste shall be removed every night. All necessary precautions shall be taken to reduce fire hazard to a minimum.
No flammable or combustible compounds or material shall be stored within any building or structure. All painting materials used on the job shall be stored in a single place designated by the Contractor. Such storage shall comply with MIOSHA requirements and the recommendations of the National Fire Protection Association (NFPA).

Upon completion of the work, if the storage space was a fixed part of the project, it shall be left clean and in as good a condition as any other area on the job. Any damages to such storage space or its surroundings shall be restored at no cost to the Owner.

1.6 WARRANTY. All work under this Section of the Specifications shall be guaranteed against checking, cracking, peeling, discoloration or other defects due to improper materials. It shall also be guaranteed against, inadequate workmanship due to improper preparation of the surfaces which were not in proper condition to receive paint, varnish or other painter's materials. All unsatisfactory work shall be completely removed and refinished in accordance with the Guarantee requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Provide continuous ventilation and heating facilities to maintain surface and ambient temperatures above 50 degrees F (10 degrees C) for Latex (water-base) paints and 45 degrees F (7.2 degrees C) for solvent-thinned paints for 24 hours before, during and 48 hours after application. Otherwise follow manufacturer's instructions.

Apply Latex (water-base) paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 degrees F (10 and 32 degrees C) and at least 5 degrees F (2.8 degrees C) above the dew point unless required otherwise by manufacturer's instructions.

Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 degrees F (7.2 and 35.0 degrees C) and at least 5 degrees F (2.8 degrees C) above the dew point unless required otherwise by manufacturer's instructions.

Do not apply paint in snow, rain, mist, or when relative humidity exceeds 85%, or to damp or wet surfaces, unless otherwise permitted by paint manufacturer's printed instructions, or when the wind direction and velocity is such that overspray will not

fall on objects not scheduled to be painted or which cannot be protected from overspray.

Painting may be continued during inclement weather if areas and surfaces to be painted are enclosed, heated and dehumidified within the temperature limits specified by paint manufacturer during application and drying periods.

Provide lighting level of 80 ft.-candles measured mid-height at substrate surface.

Material specified for all coats applied to fabrics and vapor barrier jackets over insulation shall contain a fungicide that will not adversely affect the color, texture, or durability of the coating. The paint shall contain a fungicide incorporated into the paint by the manufacturer.

Paints and painting practices shall comply with all applicable state and local laws enacted to insure compliance with Federal Clean Air Standards.

Paints containing lead or chromium in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead or chromium metal) shall not be used.

Mercurial fungicides shall not be used.

2.2 MATERIALS. The products of manufacturers not named may be submitted for use provided they are equal in quality and grade to the primers and finishes specified. If substitute paint products are desired, submit a statement to the Engineer giving the manufacturer's name, proposed primer and finish for each paint system, analysis of each type of paint, and the use or uses intended.

The painting systems required for the various surfaces shall be in accordance with the following paragraphs, unless specified otherwise in the finish schedule or other sections of the specifications. All coats shall be applied to the dry film thickness (DFT) specified. Products of other manufacturers meeting or exceeding these specifications will be acceptable.

2.2.01 Ferrous Metal Surfaces, Interior, Non-Submerged. Surface preparation shall be in accordance with SSPC-SP 6 - Commercial Blast Cleaning. Primer shall be one coat (2.5-3.5 mils DFT) Tnemec "37H Chem-Prime H.S." and finish shall be two coats (3-4 mils DFT)Tnemec "n69 Hi-Build Epoxoline II or n69F Hi-Build Epoxoline II when temperature is below 55ºF at coat application ". Or for primer use one coat (3-4 mils DFT) Carboline "888 Primer" and for the finish coat use two coats (3-4 mils DFT) Carboline "Carboguard 890".

2.2.02 Ferrous Metal Surfaces, Exterior, Non-Submerged.
Surface preparation shall be in accordance with SSPC-SP6-Commercial Blast Cleaning. Spot prime bare areas with one coat (3-5 mils DFT) Macropoxy 646 (or Duraplate 235 for cold weather application). The intermediate coat shall be one coat (4-5 mils DFT) Macropoxy 646 (or Duraplate 235 for cold weather application). The finish coat shall be one coat (1.5-2.5 mils DFT) Acrolon 218HS or High Solids Polyurethane.

As an alternative, the primer shall be one coat (3-5 mils) DFT Carboline “888 Primer”. The intermediate coat shall be one coat (4-5 mils DFT) Carboline “Carboguard 890”, and the finish coat shall be one coat (1.5-2.5 mils DFT) “Carbothane 134 HG”.

As second alternative, the primer shall be one coat (2.5-3.5 mils) DFT Tnemec “37H Chem-Prime H.S.” The intermediate coat shall be one coat (4-5 mils DFT) Tnemec“n69 Hi-Build Epoxoline II or n69F Hi-Build Epoxoline II when temperature is below 55ºF at coat application ", and the finish coat shall be one coat (2-5 mils DFT) Tnemec “1074 Endura-Shield".

As a third alternative, the primer shall be one coat (2-3 mils DFT) International Paint LLC “Devoe 201H”. The intermediate coat shall be one coat (4-6 mils DFT) International Paint LLC “Devoe 231 Series”. The finish coat shall be on coat (2-3 mils DFT) International Paint LLC “Devoe 379 Series

2.2.03 Ferrous Metal Surfaces, Submerged. Surface preparation shall be in accordance with SSPC-SP 10 – Near-White Blast Cleaning. The primer shall be one coat (4-6 mils) DFT Carboline “888 Primer” and the finish coat shall be two coats (4-6 mils DFT) Carboline “Carboguard 890". Or the primer shall be one coat (3-5 mils DFT) Tnemec “N27 S.T. Typoxy”, and the finish shall be Tnemec “69 High-Build Epoxoline II”, two coats, 4-6 mils DFT, each.

As a second alternative, the primer shall be one coat (4-6 mils DFT) International Paint LLC “Devoe 236” and the finish coat shall be two coats (4-6 mils DFT) International Paint LLC “Devoe 236”.

As a third alternative, the primer shall be one coat (4-8 mils DFT) Sherwin- Williams DuraPlate 235 and finish coat shall be one coat (4-8 mils DFT) Sherwin-Williams Dura-Plate 235.

2.2.04 Ferrous Metal Surfaces, Submerged (NSF Certified Systems). Surface preparation shall be in accordance with SSPC-SP 10 – Near-White Blast Cleaning. The primer shall be Carboline “Carboguard 891”, one coat, 4-6 mils DFT, and the finish coat shall be Carboline “Carboguard 891”, 2 coats, 5-7 mils DFT. As an alternative the primer shall be Tnemec “N140 Pota-Pox Plus”, one coat, 4-6 mils DFT and the finish coat shall be Tnemec “N140 Pota-Pox Plus”, two coats, 5-7 mils DFT. A second alternative would be to use no primer and use as the finish coat

Sherwin Williams “Hi-Solids Catalyzed Epoxy”, three coats (use different color for second coat), 5-7 mils DFT.

2.2.05 Hollow Metal Work, Exterior. Surface preparation shall be in accordance with SSPC-SP 3 - Power Tool Cleaning. The prime coat shall be Tnemec “37H Chem-Prime H.S.”, one coat, 2.5-3.5 mils DFT or Tnemec “N27 S.T. Typoxy”, one coat, 2.5-3.5 mils DFT, the intermediate coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 3-4 mils DFT, and the finish coat shall be Tnemec “74 Endura-Shield”, one coat, 1.5-2.5 mils DFT. As an alternative, the primer coat may be Carboline “888 Primer”, one coat, 2.5-3.5 mils DFT, the intermediate coat shall be Carboline “Carboguard 890”, 3-4 mils DFT and the finish coat shall be Carboline “Carbothane 134 HG”, one coat, 1.5-2.5 mils DFT.

2.2.06 Hollow Metal Work, Interior. Surface preparation shall be in accordance with SSPC-SP 2 - Hand Tool Cleaning. The shop primer shall be Tnemec “37H Chem-Prime H.S.”, one coat, 2.5-3.5 mils DFT, and the finish coat shall be Tnemec “69 High-Build Epoxoline II”, two coats, 2.5-3.5 mils DFT, each. As an alternative, the shop primer may be Carboline “888 Primer”, one coat 2.5-3.5 mils DFT, and the finish coat shall be Carboline “Carboguard 890”, two coats, 3-4 mils DFT, each.

2.2.07 Galvanized Surfaces, Exterior. Surface preparation shall be in accordance with SSPC-SP 1 - Solvent Cleaning. No primer is required and the finish coat shall be Tnemec “69 Hi-Build Epoxoline II”, two coats, 2.5-3.5 mils DFT, each as an alternative the finish coat shall be Carboline “Carboguard 890”, two coats, 3-4 mils DFT, each.

2.2.08 Galvanized Surfaces, Interior. Surface preparation shall be in accordance with SSPC-SP16 Brush-Off Blast Cleaning of Non-Ferrous Metals. Prime Coat shall be Tnemec Series 66 Hi-Build Epoxoline at 2.0-4.0 mils DFT. Finish Coat shall be Tnemec Series 290 CRU at 2.0-3.0 mils DFT.

2.2.09 Aluminum. Surface preparation shall be in accordance with SSPC-SP 1 - solvent cleaning. No primer is required. The finish coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 3-4 mils DFT. Or Carboline “Carboguard 890”, one coat, 3-4 mils DFT.

Aluminum in contact with concrete, masonry, or dissimilar metals shall be thoroughly protected cathodically by means of a heavy application thereon of an approved permanent bituminous material or approved insulating product.

2.2.10 Ferrous Metal Surfaces Exposed to Heat (From 200° to 600°F). Surface preparation shall be in accordance with SSPC-SP 10 - Near-White Blast Cleaning. The primer coat shall be Tnemec “43-38H Diffused Aluminum”, one coat, 1.2 mils DFT and the finish coat shall be same as primer, one coat, 1 mil DFT. Or the primer shall be Carboline “Thermaline 4900”, one coat, 2.5 mils DFT and the finish coat shall be same as primer, one coat, 2 mil DFT.

2.2.11 Concrete Ceilings. Surface preparation shall allow concrete to cure 28 days, if new. Remove all foreign matter; leave dust free and dry, moisture level below manufacturer's requirements. Primer coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 3-4 mils DFT and the finish coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 3-4 mils DFT. As an alternative, no primer is required and the finish coat shall be Carboline “Carboguard 890”, two coats, 3-4 mils DFT, each.

2.2.12 Concrete Building Walls, Interior. Surface preparation shall allow concrete to cure 28 days, if new. Remove all foreign matter, leave dust free and dry, moisture level below manufacturer's requirements. Primer coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 3-4 mils DFT and the finish coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 5-6 mils DFT. As an alternative, the primer coat shall be Carboline “Carboguard 890”, one coat, 3-4 mils DFT, and the finish coat shall be Carboline “Carboguard 890”, one coat, 5-6 mils DFT.

2.2.13 Concrete Block Masonry, Interior. Surface preparation shall be general cleaning. The primer coat shall be Tnemec “54-660 Masonry Filler” and the finish coat shall be Tnemec “69 Hi-Build Epoxoline II”, two coats, 3-4 mils DFT, each. As an alternative, the primer coat shall be Carboline “Carboguard 954 HB 9029” and the finish coat shall be Carboline “Carboguard 890”, two coats, 3-4 mils DFT, each.

2.2.14 Concrete Surfaces Inside Tanks (Subject To Immersion). Surface preparation shall be to abrade per ASTM D4259. The primer coat shall be Tnemec “69 Hi-Build Epoxoline II”, two coats, 10 mils DFT with no finish coat. As an alternative, the primer/finish coat shall be Carboline “Carboguard 890”, two coats, 10 mils DFT; Tnemec “N140 Pota-Pox Plus”, two coats, 10 mils DFT; or Carboline “Carboguard 891”, two coats, 10 mils DFT.

2.2.15 Concrete Floors. Surface preparation shall be to etch new floors with muriatic acid, flush thoroughly with clean water and dry for a minimum of 72 hours. The primer coat shall be Tnemec “69 Hi-Build Epoxoline II”, one coat, 3-4 mils DFT, and the finish coat shall be Tnemec “69 Hi-Build Epoxoline II”, non-skid, one coat, 3-4 mils DFT, each. As an alternative, the primer: Carboline “Carboguard 890”, one coat, 2-3 mils DFT, and the finish coat shall be Carboline “Carboguard 890”, non-skid one coat, 3-4 mils DFT.

2.2.16 Concrete or Concrete Block Masonry, Exterior. Surface preparation shall allow to cure 28 days, if new. Remove all foreign matter, leave dust free and dry, moisture level below manufacturer's requirements for concrete. Perform general cleaning for block walls. The primer coat shall be Tnemec “69 Hi-Build Epoxoline II”, two coats, 3-4 mils DFT, each, and the finish coat shall be Tnemec “75 Endura-Shield”, one coat, 1.5-2.5 mils DFT. As an alternative, the primer coat shall be Carboline “Carboguard 890”, two coats, 3-4 mils DFT, each, and the finish coat shall be Carboline “Carbothane 134 HG”, one coat, 1.5-2.5 mils DFT.

2.2.17 Woodwork, Interior. Surface preparation shall be to sand smooth and wipe clean of all dust, coat all knots, pitch and sapwood with an approved knot sealer. After priming, fill all holes, cracks, open joints and other holes with approved spackling putty. The primer coat shall be Tnemec “37 H Chem-Prime HS”, one coat, 2.0-3.0 mils DFT, and the finish coat shall be Tnemec “6 Tneme-Cryl SCI”, one coat, 2.0-3.0 mils DFT. As an alternative the primer coat may be Carboline “Carbocrylic 120”, one coat, 1-2 mils DFT and the finish coat may be Carboline “Carboline 3350”, one coat, 2.0-3.0 mils DFT.

2.2.18 Woodwork, Exterior. Surface preparation shall be sand smooth and wipe clean of all dust, coat all knots, pitch and sapwood with an approved knot sealer. After priming, fill all holes, cracks, open joints, and other holes with spackling putty. The primer coat shall be Tnemec “N27 ST Typoxy”, one coat, 2.0 mils DFT, the intermediate coat shall be Tnemec “23 Enduratone”, one coat, 3-4 mils DFT, and the finish coat shall be Tnemec “74 Endura-Shield”, one coat, 1.5-2.5 mils DFT. As an alternative the primer coat Carboline “888 Primer”, one coat, 2.0 mils DFT, the intermediate coat shall be Carboline “Carboguard 890”, one coat, 3-4 mils DFT, and the finish coat shall be Carboline “Carbothane 134 HG”, one coat, 1.5-2.5 mils DFT.

2.2.19 Insulation Materials. Insulation materials, including insulated pipe, ducts, equipment and appurtenances, shall be coated with glue sizing or a primer sealer before application of finish coat. Primer sealer shall be Tnemec 51-792 Vina-Cryl Primer or equal. Finish coats shall be the same as used for adjacent surfaces unless otherwise directed by the Contractor.

2.2.20 Shop Painting. All fabricated steel work and equipment shall receive at the factory at least one shop coat of prime paint compatible with the paint system required by these specifications. Equipment or steel work that is to be assembled on the site shall likewise receive a minimum of one shop coat of paint at the factory.

Finish coats may be applied in the shop if approved by the Engineer. All shop painted items shall be properly packaged and stored until they are incorporated in the work.

Any painted surfaces that are damaged during handling, transporting, storage, or installation shall be cleaned, scraped, and patched before field painting begins so that the work shall be equal to the original painting received at the shop.

The contractor shall specify the shop paints to be applied when ordering equipment in order to assure compatibility of shop paints with field paints.

2.3 COLOR SCHEDULE. Pipe and equipment colors shall be in accordance with DWSD Standards. Refer to finish schedule for all paint colors and locations.

Primer shall be applied as identified in each section.

On pipes, coloring shall be done in conjunction with number and color of stripes specified.

Color shall meet the tests specified in Section 3, Color Definitions, of ANSI Z53.1 “Safety Color Code for marking Physical Hazards.”

Field Painting shall be in accordance with the following color code charts, unless otherwise identified by Owner to be shop painted:

COLOR CODE

EQUIPMENT	COLOR
Bins	See Note 1
Compressors	See Note 1
Conveyors	See Note 1
Couplings	
Eddy Current	Yellow
Fluid	Yellow
Cranes (Hoists)	Yellow
Blocks	Yellow & Capacity in Black
Disintegrators	Yellow
Ejectors	See Note 1
Fans	Orange
Feeders	See Note 1
Filters	See Note 1
Flow Meters	See Note 1
Gear Reducers	Yellow
Guards	Orange
Potable Water Hydrants	Red
Motors	Orange
Pumps	See Note 1
Screens	See Note 1
Switch Enclosure	Orange

Tanks	See Note 1
Valves	See Note 1
Valve Operator	Yellow
Hand Rails	Orange – See Note 2
Removable Section of Hand Rails	Yellow & Black
Fire Protection Equipment	Red
Emergency Stop Bars, Buttons, etc.	Red
Sliding Elevator & Fire Doors	Yellow – 6" Wide
a) Vertical Edge of Horizontal	
b) Horizontal Edge of Vertical	
First Aid Kits & Encl. – Containing First Aid Equip.	Green
Safety Shower, Face Washes etc. (area around)	Green
Transformers	No Established
Switchgear	Color, Selection
Incinerators	Will be up to the Engineer
Misc. Metals	Will be up to the Engineer

Notes:
1. Color will depend on the service. The color will be obtained from "PIPE COLOR CODE, D.M.W.D." for the service (No stripes used on equipment).
2. Brass, aluminum or stainless steel is not to be painted.
3. Stripes will be 3" wide – diagonal.

PIPE	PIPE COLOR	COLOR OF STRIPES QTY)
WATER		
Potable Water	Green	None
Gland Seal	Dark Green	Yellow (1)
Hot (140 Degree Service)	Dark Green	Aluminum (1)
Secondary Water	Dark Green	Aluminum (3)
Wash Water Process	Dark Green	Aluminum (2)
Surface Wash Supply	Dark Green	Orange (2)

Unfiltered Water – Flush	Brown	Green (2)
Fire Protection	Red	Green (1)
Feed Water	Dark Green	Yellow (3)
<u>HEAT TRANSFER MEDIA</u>		
Low Pressure Steam	Orange	None
High Pressure Steam	Orange	Aluminum (1)
Blow Off Steam	Orange	Green (3)
High Temperature Hot Water	Orange	Green (2)
Thermal Liquid	Orange	Blue (1)
Condensate	Orange	Blue (2)
<u>GASES</u>		
Service Air	Purple	Green (1)
Instrument Air	Purple	Yellow (1)
City Gas	Yellow	None
Vacuum	Aluminum	Blue (1)
Vacuum Cleaning	Aluminum	Yellow (1)
Oxygen	Yellow	Orange (4)
Hydrogen	Yellow	Blue (4)
Nitrogen	Purple	Orange (1)
<u>DRAINAGE</u>		
Roof Conductors	Brown	
Sump Pump Disc	Brown	Green (1)
Wash Water Drain	Brown	Yellow (2)
Soil Pipe and Vent	Black	
<u>ELECTRICAL</u>	Aluminum	
<u>SEWAGE</u>		
Raw Sewage	Brown	Yellow (1)
Effluent	Brown	Orange (1)
Sludge	Brown	Aluminum (1)
Supernatant Liquor	Brown	Aluminum (2)

Elutriate Filtrate	Brown	Orange (2)
Grease	Brown	Blue (1)
Hot Scrubber Effluent	Brown	Blue (2)
OIL	Orange	Brown (1)
CHEMICALS		
Chlorine	Yellow	Blue (3)
Chlorine Solution	Yellow	Green (1)
Chem. Solution-Kathene	Yellow	Brown (1)
Lime	Yellow	Aluminum (1)
Alum	Yellow	Blue (1)
Carbon	Yellow	Aluminum (3)
Caustic	Yellow	Green (4)
Ammonia	Yellow	Brown (4)
Sulphur Dioxide	Yellow	Orange (1)
Sodium Chloride	Yellow	Brown (3)
Chlorine Dioxide	Yellow	Orange (2)
Ferric Chloride	Yellow	Green (2)
Polymer No.1 (Primary Settling)	Yellow	Brown (2)
Polymer No.2 (Filtration Lime Solution)	Yellow	Blue (2)
Lime Solution	Yellow	Aluminum (2)
Hydrofluosilicic Acid	Yellow	Green (3)
Pickle Liquor	Yellow	Orange (3)

Note: Stainless steel, copper and plastic piping; 6-inch wide band with ¾-inch stripes with 1-inch wide spacing.

2.4 PAINTING AND TESTING EQUIPMENT. Provide 2 of each of the following paint inspection tools for use by the Engineer.

Surface Temperature Thermometer shall be Pacific Transducer Corp. Model No. PTC 312F.

Psychrometer shall be Belfort Instruments Phychron (Mercury) Model No. 566-2, including one pair of replacement bulbs and one box of replacement wicks.

Surface Profile shall be Testex Set with Replica Tape (X-Coarse)..

Pictorial Standards shall be SSPC-Vis 1 and SSPC-Vis 2.

Wet Film Thickness Gage shall be Nordson Model No. 790-010.

Dry Film Thickness Gage shall be PosiTector 2000 with NIST Calibration Standards (Range 1.5-8 mils).

Low Voltage Holiday Detector shall be Tinker and Rasor M-1 including one replacement sponge M1-S.

Adhesion Tester shall be Elcometer 106.

Tool Box for storage of the above inspection tools (2 sets). Tool Boxes shall be made from molded durable gray plastic with tray and approximately 19 inch (48.3 cm) wall x 12 inches (30.5 cm) deep x 12 inches (30.5 cm) high.

PART 3 – EXECUTION

3.1 INSPECTION. Verify that substrate conditions are ready to receive work as instructed by the product manufacturer. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces of Masonry, Concrete and Concrete Unit Masonry are below 12 percent.

Beginning of installation means acceptance of substrates.

Test surfaces for chloride contamination (soluble salts) using Chlor*Test field kits by Chlor*Rid.

3.2 PREPARATION. Before commencing work, remove hardware, accessories, plates, lighting fixtures and similar items that are not to be painted, or in place, provide ample protection for such items. Replace such items after completion of each space. Do not remove UL labels on fire doors and frames.

The following items shall be masked or protected with suitable covering:

Sealing and glazing compounds (unless otherwise directed by the. A job site meeting shall be held before start of Work to review procedures.

Equipment identification, performance rating and other informational plates.

Moving parts of machinery and other mechanical equipment such as shafts, couplings, valve stems, fire protection system sprinkler heads and similar items.
Factory finished items.

All spaces shall be clean before painting commences, and all surfaces to be painted shall be dry. Remove all dust, dirt, grease, form oil and other foreign matter that would affect the finished work.

Inspect all surfaces to be coated and perform surface preparation in accordance with requirements of the manufacturer of the coating to be applied to each of the surfaces, or to the requirements specified herein if not provided by the manufacturer.

All surface preparation shall be as defined by the latest edition of the "Manual of Good Painting Practice" published by the Society for Protective Coating (SSPC), 4400 Fifth Avenue, Pittsburgh, Pennsylvania and hereinafter referred to as SSPC.

Should any surface be deemed unsatisfactory to produce a proper finish, the Engineer shall be notified in writing and no further material shall be applied until the problem has been resolved.

Abraded or otherwise damaged portions of shop applied paint shall be repaired using such materials and procedures as approved by the manufacturer of the damaged coating.

The Contractor shall be responsible for the compatibility of field applied coating over previously coated surfaces.

When more than one coat is to be applied, each coat should have a marked visual difference from the preceding and following coats. Undercoats shall be of approximate shade of final coat, but each coat shall be of slightly different tint to allow verification of coverage. Each coat shall be inspected before application of the succeeding coats, otherwise no credit for coat applied will be given and the work in question shall be recoated.

For ferrous metals, fill dents, hollows and other irregularities with approved metal filler suitable for the purpose. After setting, sand to a smooth, hard finish.

All ferrous metal to be primed in the shop shall have all visible rust, dust and scale as well as all other foreign substances removed by abrasive blasting to SSPC SP-10 "Near White" standard, except that structural steel and trusses shall be cleaned per SP-3 standard

All ferrous metals not primed in the shop shall be abrasive blasted in the field prior to application of the primer, pretreatment or paint

Cleaned metal shall be primed or pretreated within 6 hours after cleaning to prevent new rust formation

All nonferrous metals, whether shop or field primed, shall be cleaned with the correct solvent for the material prior to the application of the pretreatment (priming) and painting.

Galvanized metal surfaces, in accordance with SSPC-SP-1, shall be washed with a solution of Tri-sodium Phosphate (TSP), Detergent, and warm water. The solution shall consist of 2/3 cup TSP, 1/3 cup detergent in 3 quarts of warm, clean water to remove the solution. Improper washing will result in a coating failure.

Factory primed and/or finished surfaces shall be tested for coating integrity and cure by a MEK (Methyl Ethyl Ketone) Tub Test (ASTM D5402). If surface tested softens, detergent wash entire surface to remove grease and oil. Allow to thoroughly dry and paint as scheduled. If surface tested does not soften, hand abrade with emery cloth, solvent wipe with mineral spirits, and paint as scheduled.

For concrete and unit masonry surfaces scheduled to receive paint finish remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and also to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry. Fill cracks and irregularities with Portland cement grout to provide uniform surface texture. Smooth rough spots on concrete block and joints with a stone sander. All masonry surfaces shall be scrubbed clean with soap and water before applying paint or coatings.

Before applying paint or coatings to concrete floors, or other surfaces, these surfaces shall be etched with a 15 percent solution of muriatic acid to remove efflorescence and laitance, clean the surface, remove glaze and roughen concrete surfaces for proper adhesion. If the concrete surface is exceedingly dense a greater strength acid or a second etching may be required. The acid shall be washed off with water 30 minutes after it is applied (ASTM D4260)

Before applying paint or coatings to submerged concrete, these surfaces shall be lightly sandblasted to remove all form oil, curing oil, laitance, soluble salts, loose concrete or any other foreign substance which may interfere with the bonding of the paint or coating to the concrete surface (ASTM D4259)

Wood Surfaces to be painted shall be cleaned of foreign matter. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed or touched up, or both, before applying water-thinned paints to the adjacent surfaces. Small, dry, seasoned knots shall be scraped, cleaned, and given a thin coat of knot sealer, equal parts shellac and alcohol, before application of the priming coat. Pitch on large, open, unseasoned knots and all other beads or streaks of pitch shall be scraped off, or, if still soft, removed with mineral spirits or turpentine, and the resinous area thinly coated with knot sealer. Surfaces shall be checked to insure that finishing nails have been properly set, and all holes and surface imperfections shall be filled with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth with sandpaper. Putty or wood filler used shall be compatible with subsequent coatings. Painting shall proceed when the moisture content of the wood does not exceed 12 percent as measured by a moisture meter, unless otherwise authorized.

Before applying sealer to gypsum board surfaces, remove loose dirt and dust by brushing with a soft brush or by rubbing with a soft cloth. Joint treatment shall be thoroughly dry before application of sealer or paint, 12 to 18 hours under normal conditions.

All surfaces shall be thoroughly cleaned, smooth, dry and free from rust, dust, grit, efflorescence, oil and frost before painting. Dust shall be removed before succeeding coats are applied.

3.3 PERFORMANCE.

3.3.01 System Description. All unfinished surfaces, both interior and exterior, shall be painted to effect a complete project in every respect even though every item or surface may not be specifically mentioned. Paint surfaces of architectural work including structural steel, miscellaneous metals, concrete and masonry block walls, metal wall panels, doors of all types, dock levelers, gypsum wallboard, undersides of exposed roof and floor decks. Paint all unfinished surfaces of mechanical and electrical work including ductwork, piping, tanks, pumps, fans, valves, fittings, conduit, panels, boxes, hangers, anchors, supports, fittings and unfinished equipment, except as otherwise required.

Touch-up damaged or defective shop prime painted surfaces. Clean and repaint existing painted surfaces if required.

Provide all scaffolds, staging, ladders, drop cloths and other equipment required for the work.

Shop-primed ferrous metals such as structural and miscellaneous metals, metal doors and other items will require no additional coat of primer other than touch-up.

All painting shall be carefully done by skilled painters. The work areas shall be left clean and acceptable to the Engineer.

All coats of paint shall be compatible with previously applied coats. Colors and sheens shall in general match existing surfaces, DWSD Standards, or as selected by the Engineer.

Nothing in these specifications shall be deemed to cancel or supersede the directions of the manufacturers, except where specific film thickness of spreading rates are set forth, the most stringent shall take precedence.

A qualified representative of the manufacturer shall be available to instruct the painters on any special requirements or techniques for the application of the paints, coatings, etc. at no additional cost to the owner.

The Contractor shall be expected to provide tools and equipment in first class working order including moisture traps in air lines to pressure pot and spray gun when air atomization is used. Moisture shall be set for continuous bleed during spraying operation.

3.3.01 Application. No interior painting shall be started until the structure has been enclosed, ventilated, thoroughly dried out, and inspected by the Engineer.

Apply materials under adequate illumination and ventilation. Special fans shall be provided when natural ventilation is insufficient and if required, face masks shall be provided for the painters. Written consent of the Engineer will be required before building fans may be used.

Allow exterior paints and finishes to dry at least 48 hours between coats. Allow interior paints to dry at least 24 hours between coats.

Allow enamels, lacquers and varnishes to dry at least 48 hours between coats. Allow additional drying time if conditions warrant, assuring that all coats are perfectly dry before applying succeeding coats.

Remove or protect during painting all finish hardware, accessories, fixtures and similar items installed prior to painting and not required to be painted. If removed, carefully replace and adjust on completion of painting.

All work shall be performed by experienced and competent painters in conformance with the requirements of the specifications.

Paint all unfinished items which will be exposed to view after completion of the building to match adjacent surfaces, except for prefinished or plated surfaces.

Prime unprimed surfaces and apply finish coats, including adjacent closets and storage rooms, free standing columns and piers and free standing stub walls.

All piping shall be identified, including exposed piping and concealed piping, painted or not painted. Identification shall be a combination of painted pipes and fitting colors, or colored bands and lettering as required to match the existing DWSD piping identification system. Fire protection piping shall be continuously painted with safety red paint.
Electrical conduit shall be identified by marks not more than 50 feet (15.2 m) apart by stenciling or adhesive labels. Identification marking shall give voltage of conductors in conduit. Systems other than light and power shall also be identified by name.

Application may be by brush, roller or spray as required by the material used and surface to be covered. Rollers for applying enamel shall have a short nap. Spray equipment shall be as recommended by the manufacturer of the paint used. Areas inaccessible to spray painting shall be coated by brushing or other suitable method.

Provide barrier coats over incompatible primers or remove and reprime. Notify Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

Piping shall not be painted until piping system has been tested and approved.

Finished surface shall be uniform in finish and color and free from brush marks, sagging, rippling and other imperfections.

Should any coat be judged unsatisfactory, the coat shall be sandpapered or otherwise cleaned off and another coat applied. If the undercoating is disturbed, complete refinishing will be required.

Finish all returns, edges and recesses which will be exposed in the finished work and which will be seen from any angle to match the adjacent work.

Finish with flat gray-black paint all surfaces situated behind grilles or seen from any other angle, except interior duct surfaces.

Paint edges of wood doors scheduled to be painted with the same material and number of coats scheduled for faces. This work shall be done in all cases after the doors have been fitted and are ready for final hanging.

Edges of paint or finish adjoining other materials or colors shall be sharp and clean without overlapping.

Should workmanship be found defective, proper preparatory work shall be done and additional coats applied as necessary to give a finish in accordance with specified requirements.

3.3.02 Protection. Furnish and lay drop cloths in all areas where painting work is being done, to protect floors and all other adjacent work and materials from defacement. Remove all temporary protections and properly replace and adjust all enclosures, coverings, fixtures, etc. removed from any part of the work or equipment immediately upon completion of painting in the area. Any damage resulting from neglect of this requirement shall be repaired at the Contractor's expense to the complete satisfaction of the Engineer.

Maintain the work in a neat and orderly condition, promptly removing empty containers, wrappings, waste, rubbish and like matter from site. Mix paints, varnishes and lacquers only in a designated area at the site. Provide galvanized steel pans in which all mixing pails or barrels shall be kept. No mixing will be permitted outside the pans.

Freshly painted surfaces shall be legibly posted "Wet Paint" signs as such immediately following their completion.

The contractor shall use whatever means deemed advisable to protect all surfaces from accidental over spraying, spattering, or spillage of paint.

The contractor shall be responsible for all corrections and/or repairs resulting from his painting operation or that of his personnel.

3.3.03 Mixing and Thinning. Packaged paint, other than cement-emulsion filler, may be thinned when necessary to suit conditions of surface, temperature, weather, and application methods. The use of thinner shall be in accordance with the coating manufacturer recommendation. Paints of different manufacturers shall not be mixed.

3.3.04 Cleaning. Upon completion of each day's work, the painter shall return all paints and materials to the area designated by the Engineer, dispose of all waste and oily rags and remove any paint spots or spatters that may have fallen on the floor or walls and, in general, leave the area in a neat, orderly condition.

Once painting is started, perform no further broom cleaning. Use only commercial vacuum cleaning equipment.

3.4 FIELD QUALITY.

3.4.01 Field Testing. The Engineer reserves the right to inspect all surfaces deemed ready to receive a coating before the application of the next succeeding coat. The Contractor will be notified if this right is invoked, and if he proceeds without approval, after being notified, he may, at the discretion of the Engineer, be required to remove and/or recoat all such work at no additional cost to the Owner.

General inspection may be done by the Engineer and/or Coating Supplier.

The Contractor shall schedule and coordinate this work with the Engineer to allow for expeditious inspection including the use of ladders, scaffolds, swings and stages to provide regular access for inspections.

End of Section

SECTION 09960

HIGH PERFORMANCE COATINGS

PART 1 – GENERAL

1.1 SCOPE. This section covers 2 types of specialized coating systems that focus on chemical resistance and wear resistance. The chemically resistant system is a catalyzed vinyl ester coating system designed to be applied as a liner to the floor and walls of chemical storage areas or as a topping to the floor to chemical filling stations. The wear resistant system is a multipart film forming urethane system designed to be applied in warehouses, parking garages, and vehicle maintenance bays. Both finishes are intended for application over concrete.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) C957 – Specification for High Solids Content, Cold Liquid Applied.

ASTM D4263 – Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

ASTM D4258 – Specification for Practice for Surface Cleaning Concrete for Coating.

ASTM D4259 – Specification for Practice for Abasing Concrete.

ASTM D4541 - Test Method for Pull-Off Strength of Coatings Using Portable Adhesives Testers.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor's Qualifications. The coating applicator shall have 5 years of documented experience as applicator of the system used and shall be licensed by the manufacturer. Contractor shall provide a list of completed projects of similar scope and complexity complete with references, addresses, and telephone numbers.

1.3.02 Manufacturer's Field Services. The material manufacturer shall provide engineering field services to review the project and the method of material application prior to application. Approval of the application shall include the material and the procedure to be used to provide the minimum pull-off adhesion strength, surface preparation, and observation of application. The field representative of the material manufacturer shall submit, in writing through the contractor, approvals of proposed materials, application procedures, and surface preparation. The field representative shall be an employee of the material manufacturer.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit 2 copies of manufacturer's literature for all products furnished, including appropriate Material Safety Data Sheets (MSDS) and other safety requirements.

1.4.02 Certifications. Submit copy of "Certificate of License" issued to applicator by manufacturer.

1.4.03 Samples. Submit 2 samples of each coating system, applied to 1/4 inch (6.4 mm) plywood or similar rigid base.

1.4.04 Mock-up. Provide samples of products to be applied at project site. Sample shall be representative of installed system. Samples shall be approved by the Engineer. Leave sample at job site for reference during project execution.

1.5 DELIVERY, STORAGE, AND HANDLING. Deliver materials to job site in sealed, undamaged containers with labels intact and legible, indicating material name, date of manufacture and lot number.

Store materials indoors or outdoors and covered at temperatures above 32 degrees F (0 degrees C) but not exceeding 90 degrees F (32 degrees C). Store drums on sides and pails inverted.

1.6 WARRANTY. Upon completion, on a single document, provide a copy of written guarantee, from manufacturer and applicator, against defects of materials and workmanship, for a period of 5 years, beginning with date of substantial completion of system.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Install materials in accordance with safety and weather conditions required in manufacturer's written application instructions, or as modified by applicable rules and regulations of local, state, and federal authorities having jurisdiction.

Seal doors, windows, air intake, elevators and other openings that will allow vapors to migrate into occupied spaces. Inspection of the job site by a qualified industrial hygienist before work begins and periodic air monitoring during and after application may be necessary to determine ventilation requirements according to U.S. Occupational Safety and Health Administration (OSHA).

Ventilate interior and exterior application areas and occupied spaces adjacent to application areas during application and for 8 hours minimum after application or until vapor concentrations are below Permissible Exposure Limits (PEL) listed in manufacturer's MSDS.

Remove open fires and spark producing equipment from application area until vapors have dissipated.

In order for coating systems to cure properly, do not apply coating if rain is anticipated within 8 hours of application, if air temperatures are lower than 40 degrees F (4 degrees C), if temperature is expected to drop below 40 degrees F (4 degrees C) within 24 hours of application, or if air temperature is higher than 110 degrees F (43 degrees C). Cure times specified are based on curing coating at 77 degrees F (25 degrees C) and 50 percent relative humidity. Lower temperatures and humidity require extended cure.

2.2 <u>ACCEPTABLE MANUFACTURERS</u>.

2.2.01 <u>Chemical Resistant System</u>. Shall be manufactured by Dudick, Inc. or an approved equal.

2.2.02 <u>Wear Resistant System</u>. Shall be manufactured by 3M Construction Markets Division or equal.

<u>2.2.03</u> Edge Retentive System<u>. FAST Clad Edge Retentive Epoxy: Shall be manufactured by Sherwin Williams Company.</u>

2.3 <u>MATERIALS</u>. Coating system used shall be supplied in total by a single manufacturer. Components of different manufacturer's system shall not be mixed.

2.3.01 <u>Chemical Resistant System</u>. The lining and topping coats shall be a 2 component vinyl ester coating that is 100 percent solids, solvent-free, catalyzed vinyl ester resin, graphite filled, high-build protective and waterproofing coating. Unless otherwise specified, Basecoat shall be Dudick "Protector-Coat 800"; Topcoat shall be Dudick "Protector-Coat 805". Where coating may come in contact with sulfuric acid, Basecoat shall be Dudick "Protector-Coat 900"; Topcoat shall be Dudick "Protector-Coat 905".

The concrete surface primer shall be a catalyzed vinyl ester resin containing conductive fillers, 100 percent solids content and shall be Dudick "Primer 27C"

2.3.02 Wear Resistant System. Shall be liquid applied, urethane 319 Scotch-Clad Deck Coating system or approved equal. Concrete primer shall be Scotch-Clad concrete primer. Base coating shall be Scot-Clad base coat 5893. Intermediate coat (if applicable) shall be Scotch-Clad Intermediate coat 5768 LC. Top coat shall be Scotch-Clad Top Coat 5891. Aggregate shall be silicon carbide, 24 mesh, or silica sand (12-20 mesh) as defined in Finishes schedule.

Thicknesses of intermediate coat and quantities of aggregate per square foot shall be defined in the Finishes schedule based on wearability desired.

2.3.03 Accessories for Wear Resistant System. Primers shall be Scotch-Clad Concrete Primer.

Backer Rod shall be closed cell urethane foam rod.

Sealant shall be low modulus, unmodified polyurethane or polysulfide based.

Sheet Flashing shall be 50 mils (1.3 mm) thick, procured, commercial grade neoprene.

Flashing Reinforcement shall be non-woven, uncoated fiberglass mesh.

Detail Coat shall be Scotch-Clad Non-Flow Base Coat by 3 M applied 25 dry mils (0.6 mm) thick, 11 to 12 dry mils (0.27 mm to 0.3 mm) topcoat on U.V. exposed vertical.

Aggregate shall be locally obtained silicon carbide 24 mesh or aluminum oxide.

Cleaning Agents shall be Toluene.

2.3.04 Edge Retentive System. Shall be an Edge Retentive (Not less than 70% retention required) providing rapid return to service 24-36 @ 40-70F at 50% relative humidity). Ultra high amine coating engineered for immersion service recommended for primary and secondary containment. Coating shall have a result of less than 30 mg loss when tested to ASTM D4060 test method.

Required surface preparation shall be SSPC-SP6/NACE2 near white abrasive blast B62W230/B62V230; 9-11 mils Dry Film Thickness (DFT).

Finish Coat: Fast Clad Edge retentive epoxy B62W230/B62V230 9-11 dft. Total System DFT 18-22 mills.

PART 3 – EXECUTION

3.1 INSPECTION. New concrete shall be at least 4 weeks old before lining or topping is applied, in accordance with the manufacturer's recommendations. Concrete surfaces shall be tested for capillary moisture in the concrete in accordance with ASTM D4263. Capillary moisture shall not exceed the manufacturer's recommendation.

Concrete must exhibit 3000 psi (20.7 MPa) minimum. Concrete surfaces to be coated must be trowel finished in compliance with ACI 301-84 paragraph 11.7.3 (except that hand troweling is not required), followed by a fine hair brooming, left free of loose particles, and shall be without ridges, projections, voids and concrete droppings that would be mechanically detrimental to coating application or function.

Before coating is applied, inspect slab to receive coating. Surface shall be free of voids, laitance, loose material on surface, grease, oil, rust and other contaminants, which will affect bond of coating. Inspect slab for variations in surface finish, joint offsets and other defects that may adversely affect coating application or performance.

Concrete surfaces must be visibly dry and pass a 4-hour rubber mat test (no condensation) prior to application of coating system.

Verify that curing methods used for concrete are compatible with requirements for coating system.

Commencement of coating installation implies acceptance of substrate as suitable to accept coating.

All surfaces to be lined or topped shall be cleaned in accordance with ASTM D4258 and abrasive blasting in accordance with ASTM D4259. Prior to application of the coating, the surfaces shall be thoroughly washed, or cleaned by air blast, to remove all dust and residue. Spalled areas, voids, and cracks shall be removed by Contractor from all concrete surfaces to provide a flush surface before application of lining or topping.

All surfaces shall be free of objectionable substances and shall meet the recommendations of the coating manufacturer for surface preparation.

The concrete surfaces including "bug" holes shall be prepared using materials recommended by material manufacturer. "Bug" holes may be prepared, when approved by the lining or topping material manufacturer, using the reinforced basecoat.

3.2 PREPARATION.

3.2.01 Chemical Resistant Coating Systems. Concrete must be abrasive blasted or etched with muriatic acid (Solution of 1 part 20 degree Be HCI and 1 part water) to remove surface laitance and other contaminants. Concrete must be free of curing compounds and form release agents. Surface texture should be similar to 40-60 grit sandpaper with exposed pea gravel. The prepared surface should have a minimum tensile strength of 250 psi (1,723.7 kPa) per ASTM D4541.

All concrete substrates must be cheeked for moisture prior to product application using the Plastic Sheet Test, ASTM D4263.

Additional surface preparation will be required if a 40-60 grit texture with exposed pea gravel is not achieved and the surface laitance not completely removed after a single application of acid or with the first mechanical preparation procedure. Abrasive blasting removes laitance, exposing honeycombs or voids beneath the surface which must be filled with Scratch Coat 800. (Refer to separate product bulletin)

3.2.02 Wear Resistant Coating System. Protect adjacent surfaces with drop cloths and tape to control dust and overspray and to make lines.

Clean surfaces to receive coating materials in accordance with manufacturer's instructions. Remove oil and grease with a commercial grade alkaline cleaner then thoroughly rinse and dry. Prepare concrete surface by sandblasting or shotblasting. Only new concrete (minimum 21 days) may be acid etched with 10 to 15 percent solution of muriatic acid. Flush acid with clean water and allow surface to dry one to three days. Sweep, blow or vacuum clean surfaces to be coated.

Rout or sawcut 1/4 inch by 1/4 inch (6.4 mm by 6.4 mm) minimum where system(s) is/are to be terminated in a horizontal plane, and cracks exceeding 1/16 inch (1.6 mm) wide.

Apply sealant, using backer rod as needed, to expansion, control and construction joints and routed cracks to be coated. Joints wider than 1 inch (2.5 cm) should not be coated. Install a 1/2 inch (12.7 mm) sealant cove at rigidly connected deck projections, such as many types of posts, vents, pipes, stanchions, railings, wall/slab intersections and connected items having very limited movement.

Prime concrete, masonry and metal following manufacturer's recommendations. Protect sealant from primer spray.

Install 8 inches (20.3 cm) minimum width of sheet flashing fully, bonded 3 inches (7.6 cm) minimum vertical and horizontal, and unbonded 1 inch (2.5 cm) minimum vertical and horizontal, to locations of potential high movement such as wall/slab intersections which are not structurally and rigidly connected. Do not use procured sheet flashing over expansion joints in horizontal surfaces.

Install 12 inches (30.5 cm) Flashing Reinforcement imbedded in detail coat 2 inches (5.1 cm) wider than flashing reinforcement vertical and horizontal at rigidly connected wall/slab intersections.

For vertical surfaces higher than 2 inches (5.1 cm) provide detail coating. Where water is expected to accumulate due to ponding, snow and ice build-up, excessive splashing, or other regional and project conditions, provide vertical detail coat 2 inches (5.1 cm) higher than anticipated high water exposure line.

Apply Detail Coat over preparatory work described above and cracks under 1/16 inch (1.6 mm). Extend detail coat 2 inches (5.1 cm) onto concrete surface on each side.

3.3 INSTALLATION.

3.3.01 Chemical Resistant Coating System. The following conditions must exist to begin application of the Protector-Coat 800/805 system.

Substrate temperature for both concrete and metal must be between 50 and 110 degrees F (10 and 43 degrees C).

Relative humidity must not exceed 90 percent.

Substrate temperature must be 5 degrees F (2.8 degrees C) above the Dew Point.

Hardener	**Substrate Temp.**	**Primer 27 27C**	**PC-800 B-Coat T-Coat**	**PC-805 B-Coat T-Coat**
PH-1	50 degrees F* (10 degrees C)	3-4 oz.	4-5 oz.	3-4 oz.
	70 degrees F* (21 degrees C)	4-5 oz.		
PH-1	70 degrees F* (21 degrees C)	2-3 oz.	3-4 oz.	2-3 oz.
	90 degrees F* (32 degrees C)	3-4 oz.		

Pot life of the mixed Protector-Coat 800/805 will depend on the temperature. To prevent material waste and avoid damage to equipment, do not mix more material than can be used according to the following table:

Temperature	Pot Life
50 degrees F (10 degrees C) 75 degrees F (24 degrees C) 90 degrees F (32 degrees C)	60 min. 40 min. 25 min.

Do not attempt to store mixed material. Residual material should be properly disposed of at the end of each work period.

Concrete surfaces must be thoroughly dry before the application of the primer. All concrete must be primed with either Primer 27 or 27C at 3-4 mils WFT. Do not allow the primer to puddle.

Primer 27C must be mechanically mixed for 1-2 minutes prior to adding the correct amount of PH-1 Hardener; apply using roller only. Use brush application for touch-up or repair.

To apply the basecoat and topcoat, mix the Protector-Coat 800/805 separately to redisperse pigments and fillers, which have settled. Then add the correct amount of PH-1 Hardener to the Protector-Coat 800/805 and mix thoroughly until a uniform color is achieved. Apply at 15-20 mils (0.4 – 0.5 mm) WFT using a brush, spray or roller to an even, smooth finish. Allow the basecoat to cure until “firm” or slightly “tacky” before applying the topcoat.

In order to prevent curing problems with styrenated products, air movement and/or ventilation must be maintained not only during application but also after application until the system has totally cured. This will prevent high concentration of styrene inhibiting/retarding the cure of the system.

For the Standard Formulation, use conventional air spray equipment with a pressure pot: Binks #18 spray gun with #68 fluid nozzle and #68 air nozzle, or Binks #62 spray gun with #68 fluid nozzle and #68 air nozzle are recommended.

For Plural Component use a Binks 8 to 1 pump, and Binks Model 18 NC spray gun 59BSSX9-47 with a 102-3430 ACI valve Catalyst should be supplied by a 101-5202 catalyst tank. 1/2 inch (1.3 cm) ID material supply hose is recommended.

Brush or roller application may require additional coats to meet the specified dry film thickness.

Plan ahead so that recoating can be accomplished to allow sufficient cure cycles for Protector-Coat 800/805:

Recoat Time

Temp.	Min.	Max.	Cure Time
50 degrees F (10 degrees C) 75 degrees F (24 degrees C) 90 degrees F (32 degrees C)	12 hours 4 hours 3 hours	120 hours 96 hours 72 hours	96 hours 24 hours 10 hours

If these recoat times are exceeded, consult a manufacturer. Sanding or abrasive blasting may be required before the next coat. Recoat times are dramatically reduced when the coating is exposed to direct sunlight.

Application of Protector-Coat 800/805 in direct sunlight may lead to blistering pinholes, or wrinkling due to outgassing of air in the concrete and high substrate temperatures. Double priming, shading, or evening application may be required. Consult a Dudick representative.

For cleaning use S-10 Cleaning Solvent to clean tools and equipment. DO NOT USE ACETONE.

3.3.02 Wear Resistant Coating System. Apply base coat at 25 dry mils (0.6 mm) using a notched squeegee. Extend base coat over detail coating. Back roll base coat to ensure uniform leveling.

Allow to cure for 16 hours minimum.

Apply top coat at 11 to 12 dry mils (0.27 mm to 0.3 mm) using a notched squeegee. Backroll to ensure uniform leveling before aggregate is broadcast.

While coating is still fluid, uniformly broadcast aggregate at 5 pounds per 100 square feet (2.4 kg per 10 square meters) into coating.

Immediately backroll to evenly distribute and completely coat aggregate.

For system V, allow to cure 48 hours minimum before permitting traffic on surface.

For system VHD, allow to cure overnight before applying second top coat. Apply second top coat by repeating steps for top coat above.

Allow system to cure 48 hours minimum before permitting traffic on surface.

Clean masking protection, equipment, material, and debris from surface and storage area.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. For the chemical resistant coating system where immersion service is required, spark test the coating with a 5000 volt AC spark tester. Mark and repair all pinholes using Protector-Coat 800. Retest only the repairs.

Protector-Coat 805 cannot be spark tested.

End of Section

SECTION 09962

RESINOUS FLOORING

PART I – GENERAL

1.1 SECTION INCLUDES

A. Epoxy-based floor resurfacing system.

B. Compounds and accessories needed for a complete installation.

1.2 RELATED SECTIONS

A. Section 03300 - Cast-In-Place Concrete

B. Section 09900 - Paints and Coatings

C. Section 09960 - High Performance Coatings

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM C 501 - Standard Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser.
2. ASTM D 257 - Standard Test Methods for DC Resistance or Conductance of Insulating Materials.
3. ASTM D 570 - Standard Test Method for Water Absorption of Plastics.
4. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
5. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.
6. ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
7. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer.
8. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
9. ASTM D 2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.
10. ASTM D 2240 - Standard Test Method for Rubber Property--Durometer Hardness.
11. ASTM D-2566 - Test Method for Linear Shrinkage of Cured Thermosetting Casting Resins During Cure.
12. ASTM D 2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
13. ASTM D 4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
14. ASTM D-4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
15. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association; 1997.

1.4 SUBMITTALS

A. Submit under provisions of Division 1.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Selection Samples: For each product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

D. Verification Samples: For each product specified, two samples, minimum size 6 inches (150 mm) square, representing actual flooring, color, and patterns.

1.5 QUALITY ASSURANCE

A. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in clean, unopened factory-labeled containers.

B. Store materials in manufacturer's unopened packaging until ready for installation. Store in a dry, protected area, and maintain temperature of storage area between 50 and 90 degrees F (10 to 32 degrees C).

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. At Substantial Completion, submit a one year warranty against defects in materials and workmanship

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Dur-A-Flex, Inc; 95 Goodwin Street, East Hartford, CT

06108. ASD. Tel: (860) 528-9838.

B. TNEMEC

C. Approved equal

D. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 MATERIALS

A. Epoxy Floor Resurfacing System with Colored Quartz Aggregate: Dur-A-Flex Dur-A-Quartz multiple component, seamless, decorative quartz, slip resistant flooring system with the following installed properties:
1. Shore D Hardness: 75 to 80, when tested in accordance with ASTM D 2240.
2. Compressive Strength: 17,500 psi, (120.6 MPa), when tested in accordance with ASTM D 695.
3. Tensile Strength: 4,000 psi (27.6 MPa), when tested in accordance with ÅSTM D 638.
4. Tensile Elongation: 7.5 percent, when tested in accordance with ÅSTM D 638.
5. Flexural Strength: 6,250 psi (43.0 MPa), when tested in accordance with ÅSTM D 790.
6. Water Absorption: 0.04 percent, when tested in accordance with ASTM D 570.
7. Flame Spread Index: 75 or less, when tested in accordance with ÅSTM E 84, IIA.
8. Topcoat: Dur-A-Glaze Novolac.
9. Surface Finish: Standard Slip Resistant, with 0.9 coefficient of friction per ÅSTM D 2047.
10. Color: As selected by Architect from manufacturer's standard color blends.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify that surface is dry and perfectly clean, free of all oil, grease, detergent, and other contaminants.

3.2 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. Create a surface profile with a steel shot blast machine and dust-free diamond grinders for edges.

C. Clean surfaces thoroughly prior to installation.

D. Thoroughly rout and vacuum clean moving cracks and joints; fill with manufacturer's recommended flexible filler material.

E. Repair non-moving surface deviations with manufacturer's recommended patching compound.

3.3 INSTALLATION

A. Install flooring system in strict accordance with manufacturer's instructions.

B. Mix components on site with manufacturer-supplied mix and measure apparatus to ensure timely, accurate mix ratios and to minimize waste.

C. Prime substrate with manufacturer's recommended primer and allow to cure.

D. Apply flooring system in number of coats and to thickness recommended by manufacturer.
   1. Install a 4 inch (100 mm) integral cove base at perimeter walls and columns.
   2. Key in all drains, edges, and transition points according to manufacturer's instructions.

E. Broadcast aggregate to excess, and allow to cure and subsequently sweep up excess aggregate.

F. Apply topcoat in number of coats recommended by manufacturer and allow to cure.

3.4 PROTECTION

A. Protect installed flooring until completion of project.

B. Touch-up, repair or replace damaged flooring system after Substantial Completion.

End of Section

INDEX

DIVISION 10 – SPECIALTIES

SECTION 10100

MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the miscellaneous specialty items to include anchors, coat racks, janitor closets, vestibule items, and projection accessories.

1.2 GENERAL. Miscellaneous specialties shall be furnished and installed as specified herein and in accordance with the details, arrangements, and dimensions indicated on the drawings. Where not specifically indicated or specified, fasteners, gaskets, and other accessories shall be provided as required and as recommended by the manufacturer of the specific item.

1.3 QUALITY ASSURANCE.

1.3.01 Governing Standards. Comply with ASTM, ANSI and other applicable industry standards. Electrical equipment and materials shall be UL listed, except that FIA, FM or another testing agency will be acceptable where approved by local jurisdictional authorities.

1.4 SUBMITTALS. Submit complete specifications, detailed drawings, and setting or erection drawings covering miscellaneous specialties.

1.5 DELIVERY, STORAGE AND HANDLING. Deliver items to job site in original unopened containers bearing labels identifying manufacturer brand, model number and other pertinent information. Use methods to prevent damage and deterioration.

1.5.01 Storage and Protection. Contractor shall be responsible for locating areas subject, to approval of engineer, for use as required for storage and work areas.

1.5.02 Damaged Material. Damaged, defective materials shall be identified, conspicuously marked as rejected, permanently removed from premises and replaced with suitable undamaged material at no additional cost to Owner.

PART 2 – PRODUCTS

2.1 ANCHOR MATERIALS.

2.1.01 Anchorage Devices. Type, Class and Style shall be as recommended by approved unit manufacturer to suit conditions of installation.

2.1.02 Wood Screws. Shall be flat head carbon steel; FS FF-S-111; length as recommended by approved manufacturer.

2.2 FABRICATION.

2.2.01 General. Fabricate units using materials carefully selected to be free of defects, objectionable projections, and irregularities. Make smoothly rounded corners, edges and exposed fasteners to minimize snagging and pinching hazards.

Fabricate fixed units for attachments, using methods suitable for rigid anchorage support to substrate conditions involved.

Fabricate metal units of welded tubular steel or die-formed steel panels with integral or welded edge reinforcement and welded steel feet. Provide seat mounting and back connector plates securely attached in position to maintain property relationships and clearances.

2.3 FINISHES. Unless otherwise indicated, finish exposed iron and steel components with manufacturer's baked-on enamel in color as selected from manufacturer's standards.

2.4 COAT RACKS – WALL MOUNTED.

2.4.01 Manufacturers. Provide bracket type, size and number of shelves indicated, as manufactured by A. R. Nelson Co., Inc.; Vogel-Peterson Co.; Millberg Co.; or approved equal.

2.4.02 Fabrication. Shelves shall be fabricated of four, 3/4 inch (1.9 cm) minimum O.D., 0.065 inch (1.7 mm) thick extruded aluminum tubes with manufacturer's standard clear anodized and polished finish, with ends closed by brackets or caps.

Hanger rod shall be 1 inch (2.5 cm) minimum O.D. aluminum tube finished and closed same as shelf tubes.

Brackets shall be cast aluminum with baked enamel finish in manufacturer's standard color selected by the Owner. Prevent tubing from turning in brackets.

Wall mounts shall be extruded aluminum with clear anodized and polished finish, designed to provide for vertical adjustment of brackets.

2.5 COAT AND HAT RACKS – FREE STANDING.

2.5.01 Manufacturers. Provide equal to “Model SF-CK” for single face and “Model DF-CK” for double face units as manufactured by Vogel-Peterson, length as indicated.

2.5.02 Fabrication. Provide each rack with two metal shelves and chromium-plated angular hanger rail, supplied with nylon receptacles spaced 2 1/2 inches (6.35 cm) on center, complete with T-top 17 inch (43.2 cm) hardwood hangers.

Provide bottoms of bases with plastic glides.

Adequately brace each unit to prevent lateral racking and swaying.

For metal, not chromium-plated, provide a baked enamel finish, color as indicated on the Finish Schedule.

2.6 JANITOR CLOSET UTILITY SHELF.

2.6.01 Manufacturers. American Specialties, Inc. “No. 1308”; Bobrick Washroom Equipment, Inc. “B-239”; or approved equal, approximately 34 inches (86.4 cm) wide with 3 mop holders and 4 rag and towel hooks.

2.6.02 Fabrication. Shelf and vertical strip shall be type 302 stainless steel with No. 4 finish. Mop holders shall be cadmium-plated steel, with spring-loaded, serrated rubber cams, mounted to strip.

2.7 VESTIBULE MAT.

2.7.01 Manufacturers. Provide Pawling Rubber Co. “Parco Hi-Rib”; American Floor Products Co. “Afco Hi-Rib”; R.C. Musson Rubber Co. “Deep-Rib”; or approved equal.

2.7.02 Fabrication. Shall be 7/16 inch (1.1 cm) thick solid rubber in manufacturer’s standard color selected by the Owner. Edge shall be square.

2.8 VESTIBULE GRATING.

2.8.01 Manufacturers. Product shall be Construction Specialties, Inc. “Series 1200V Vinyl Pedigrid”; Reese Enterprises, Inc. “No. 471 Perfec Clean”; or approved equal; recessed with aluminum frame, designed to support a uniformly distributed load of 200 psf (976.4 kg/sq m) without exceeding a deflection of 1/16 inch (1.6 mm).

2.8.02 Fabrication. Grating surface shall be vinyl with serrated pattern in color selected by the Engineer from manufacturer's standard range, locked and mechanically secured to the tread rails.

Tread rails shall be extruded aluminum, alloy 6063-T52, structurally joined to aluminum key lock bars, alloy 6061-T6, spaced 10 inches (25.4 cm) O.C. maximum.

Framing members shall be extruded aluminum, alloy 6063-T52, neatly coped at corners and assembled with stainless steel screws, for 4 inch (10.2 cm) nominal recess.

Finish for aluminum shall be mill finish. Surfaces in contact with concrete shall be coated with zinc chromate paint.

2.9 INTERIOR DOME.

2.9.01 Manufacturers. Provide product from Edon Corp., 1160 Easton Road, Horsham, PA., or approved equal.

2.9.02 Fabrication. Provide Fiberglass Reinforced Polyester (FRP) components using class "A" material to meet local fire codes and have a gel-coat finish with a minimum thickness of not less than 1/8 inch (3.2 mm).

2.10 PROJECTION SCREEN.

2.10.01 Manufacturers. Provide product from Da-Lite Screen Company, Inc.; Draper Shade & Screen Co., Inc.; or approved equal.

2.10.02 Fabrication. Screen surface shall be matte white surface with 2 inch (5.1 cm) black masking borders, 60 x 60 inch (1.5 m x 1.5 m) size, unless otherwise indicated, mounted on 3 inch (7.6 cm) steel roller.

Case shall be 22 gage (0.85 mm) steel finished with flat black, baked enamel finish, fitted with end caps and wall mounting brackets.

PART 3 – EXECUTION

3.1 INSPECTION. Examine areas and conditions under which Work is to be installed including condition of substrate to which fixed units are to be attached and notify in writing of conditions detrimental to proper and timely completion of Work.

3.2 PREPARATION. Protect the Work and adjacent construction against damage. All parts and assemblies shall be protected during fabrication, shipment, storage, and erection to prevent damage. Damaged units will be rejected and shall be replaced at no additional cost to the Owner.

3.3 INSTALLATION. Install each item of miscellaneous specialties in accordance with manufacturer's instructions, approved Shop Drawings, and specified requirements. Furnish each item with required fasteners.

Install in locations as shown in drawings with each fixed unit attached to substrate by not less than 2 anchoring devices of recommended size. Install operable moving components operate properly. Install closure plates and strips where required with joints coordinated with units of equipment.

Install sealants and gaskets all around each unit to make joints air-tight, waterproof, vermin-proof and sanitary for cleaning purposes. In general, make sealed joints not less than 1/8 inch (3.2 mm) wide and stuff with backer rod to shape sealant bead properly at 1/4 inch (6.4 mm) depth. Shape exposed surfaces of sealant slightly concave with edges flush with faces of materials at joint. At internal-corner joints, apply sealant or gaskets to form a sanitary cover of not less than 3/8 inch (9.5 mm) radius. Provide sealant-filled or gasket joints up to 3/4 inch (1.9 cm) joint width; use metal closure strips for wider joints, with sealant application each side of strips. Anchor gaskets mechanically or with adhesives to prevent displacement.

3.3.01 Coat Racks. Anchor wall mounts to wall with toggle bolts at maximum spacing of 38 inches (96.5 cm).

3.3.02 Utility Shelf. Anchor utility shelving to the wall in each janitor's closet as directed in plans.

3.3.03 Vestibule Mat. Install mat in floor recess with corrugations parallel to thresholds, edges square, straight and parallel to boundary of recess. Where joints are required in large mats for ease of handling, fit the joints tight.

3.3.04 Vestibule Grating. Install frame surface mounted in recess in concrete floor in a level and accurate plane. Set grating in frame.

3.3.05 Projection Screen. Install projection screens in accordance with the manufacturer's instructions, approved shop drawings and specified requirements. Furnish required fasteners.

Anchor projection screens to the wall with 3/8 inch (9.5 mm) toggle bolts at an elevation of 8 foot, 6 inches (2.6 m) above finish floor, unless otherwise indicated.

3.4 CLEANING. Upon completion, clean the Work in accordance with manufacturer's instructions. Remove protective coverings if any, and clean equipment internally and externally. Restore exposed and semi-exposed finishes to remove abrasions and other damages; polish exposed-metal surfaces and touch-up painted surfaces. Replace work, which cannot be successfully restored.

End of Section

SECTION 10150

TOILET COMPARTMENTS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers toilet components and miscellaneous toilet accessories.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standards specifications:

AA (Aluminum Association) DAF-45 – Designation System for Aluminum Finishes.

ANSI (American National Standards Institute) Z97.1 - Specification for Safety Performance Specifications and Methods of Test for Glazing Materials Used in Buildings.

ASTM (American Society for Testing and Materials) A424 – Specification for Steel Sheet for Porcelain Enameling.

ASTM A591 – Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy – Coated (Galvannealed) by the Hot-Dip Process.

ASTM A666 – Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM - B456 – Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.

ASTM C1036 – Specification for Flat Glass.

Fed. Spec. (Federal Specifications) FF-S-325 – Specification for Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry).

FS RR-P-1352 – Specification for Partitions, Toilet, Complete.

SAA (Specification for Anodized Architectural Aluminum0 46.

1.3 QUALITY ASSURANCE. Take field measurements to verify or supplement dimensions indicated. Be responsible for accurate fit of the Work.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings indicating component layout, dimensions, location, hardware, finish, manufacturer's name and catalog number, and pertinent construction and erection details. Furnish maintenance instructions for finishes and operating equipment.

1.4.02 Samples. Submit full size samples of items, if requested by the Engineer. Samples will be returned to the Contractor upon completion of the Work.

1.4.03 Record Drawings. Furnish receipts for keys for dispenser cabinet doors and other such items.

1.5 DELIVERY, STORAGE AND HANDLING. Protect the Work from damage during transportation to the Project site, storage at the site, and during progress of Work until completion.

1.6 WARRANTY. Mirrors shall be warranted for 15 years against silver spoilage.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS.

2.1.01 Partitions. Accurate Partitions Corp; Metpar Corp; The Mills Co; Sanymetal; Weis/Robart Partitions, Inc; or as approved.

2.1.02 Toilet Accessories. Bobrick Washroom Equipment, Inc. (Bobrick), A & J Washroom Accessories, Inc., American Specialties, Inc., Bradley Corp., Washroom Accessories Div., McKinney/Essex or equivalent models unless otherwise specified.

2.2 MATERIALS.

2.2.01 Toilet Compartment Steel. Steel sheets and strips shall be cold-rolled galvanized, bonderized and stretcher-leveled steel, unless otherwise specified. Minimum thickness of zinc coating shall conform to ASTM A591, Class C. Provide steel and galvanizing which does not fracture, flake or peel from the necessary forming and die-drawing operations. Flash-coated steel is not acceptable.

Metal gages for steel sheets and strips, prior to zinc coating, shall be as follows unless otherwise specified:

Face plates of doors	22 gage	(0.85 mm)
Face plates of panels	20 gage	(1.0 mm)
Reinforcement for tapping	14 gage	(1.9 mm)
Concealed reinforcement for anchoring devices	12 gage	(2.7 mm)

2.2.02 Core Material. Shall be pads of honeycomb paper expanded to 1 inch (2.5 cm) maximum cell size, with cell walls of .009 caliper kraft paper, 26 lbs/1,000 square feet (11.8 kg/92.9 sq. m) minimum, processed with flanged edges and uniform expansion, or faced with kraft paper both sides for adhesion.

2.2.03 Reinforcement. Steel for concealed reinforcement shall be hot rolled.

2.2.04 Fittings and Hardware. Brackets shall be bright chromium-plated cast brass or zinc alloy, or extruded aluminum having edges and corners rounded and polished smooth.

Hinges, coat hooks, latch and keeper shall be bright chromium-plated cast brass or zinc alloy. Latch handle and keeper may be aluminum, provided edges and corners are round.

Aluminum finish shall be AA M21A41 polished clear anodic complying with AA DAF-45 and AA SAA-46.

2.2.05 Fastenings. Hex bolts and machine screws shall be chromium-plated and concealed where possible.

2.2.06 Stainless Steel. Shall be Type 302 or 304 with No. 4 finish.

2.2.07 Chromium-Plated Brass. Exposed surfaces of brass shall be chromium-plated in accordance with ASTM B456.

2.2.08 Mirror Glass. Shall be ASTM C1036, quality Q2, Type I, Class 1, 1/4 inch (6.4 mm) thick glass complete with silvering, copper coating, and protective organic coating; silvering of pure silver, free of pinholes or other defects visible to the naked eye; two-coat abrasion resistant baked on protective coating; as manufactured by Guardian Industries Corp., or approved equal.

2.2.09 Fasteners. Provide tamperproof fasteners. Expansion shields shall be machine bolt type, tubular type, or self-drilling tubular type complying with Fed. Spec. FF-S-325. Fasteners shall be toggle bolts for hollow masonry and stud walls, expansion shields for solid masonry or concrete.

2.3 CEILING MOUNTED TOILET COMPARTMENT.

2.3.01 Type. Shall be overhead braced type with 20 gage (1.0 mm) pilasters extending from floor to approximately 12 inches (30.5 cm) above top of compartments and with extruded aluminum or 20 gage (1.0 mm) tubular steel overhead bracing. Provide overhead bracing continuous through top of pilasters and anchored to walls with brackets. Cap exposed ends of bracing.

2.3.02 Pilasters. Provide top of pilasters with leveling device to carry weight of compartment and to provide secure mechanical anchorage to structure above with adjustable fittings.

2.3.03 Fittings. Anchoring device at top of pilasters shall be12 gage (2.7 mm) hot-rolled steel plate, concealed with a 3 inch (7.6 cm) high stainless steel shoe with polished finish.

2.4 GRAB BARS.

2.4.01 Grab bar material. Shall be stainless steel tubing, with 0.050 inch (1.3 mm) minimum wall thickness, welded to flanges.

2.4.02 Joints. Shall be mortised, brazed or soldered, and ground smooth to form invisible, flush connection.

2.4.03 Flanges. Shall be designed to be anchored to mounting plates with minimum of 3 stainless steel Allen head set screws.

2.4.04 Size. Shall be 1-1/2 inch (3.8 cm) outside diameter with 1-1/2 inch (3.8 cm) clearance between rail and wall.

2.4.05 Concealed Anchors for Masonry Walls. Shall be plates with stud anchors welded on.

2.4.06 Mounting Plates for Connecting Flange to Anchors. Shall be a minimum of 12 gage (2.7 mm) case-hardened and plated steel formed to bear against set screws.

2.5 MIRRORS.

2.5.01 General. Frame shall be not less than 3/8 by 5/8 inch (9.5 mm by 15.9 mm) by 20 gage (1.0 mm) stainless steel. Each side of metal frame: one continuous piece to form square corner with corners welded and welds ground smooth. Edge of mirror shall be protected by plastic filler strips with no exposed seams or screws on frame.

Backing shall be one piece sheet metal, not less than 22 gage (0.85 mm), with galvanized or other rust and corrosion resistant finish, fitting smoothly to frame. Concealed theftproof hangers shall be securely spot-welded to back with not less than 2 welds each.

2.5.02 Mirror and Frame Units. Shall be mirror glass in frame with backing, of size indicated, Bobrick B-290 Series or approved equal.

2.5.03 Mirror and Shelf Units. Shall be mirror glass in frame with backing, of size indicated, with shelf, Bobrick B-292 Series or approved equal. Shelf shall be not less than 22 gage (0.85 mm) stainless steel, 5 inches (12.7 cm) wide by width of frame, and attached to frame with concealed stainless steel brackets.

2.6 DISPENSERS AND RECEPTACLES.

2.6.01 General. Cabinets shall be stainless steel, all welded construction with one piece seamless flanges construction, 22 gage (0.85 mm) minimum thickness.

Flush doors shall be a minimum of 22 gage (0.85 mm) double pan construction or 18 gage (1.3 mm) single sheet with flange. Doors shall be mounted on continuous stainless steel hinges. Cabinet doors shall be equipped with tumbler locks keyed alike.

Towel openings shall be hemmed.

Removable containers for waste receptacles shall be stainless steel, 28 gage (0.47 mm) minimum thickness, bottom edges hemmed.

2.6.02 Surface-Mounted Towel Dispensers. Shall be stainless steel, equipped with a tumbler lock, designed to dispense 300 C-fold or 500 multi-fold towels, one at a time, Bobrick B-262 or approved equal.

2.6.03 Towel Dispenser and Receptacle Units. Recessed towel dispenser and receptacle units shall be designed for handicapped use to dispense all makes of C-fold and multi-fold paper towels, have removable waste container and two flush cabinet doors with two locks, Bobrick B-3900 or approved equal.

2.6.04 Sanitary Napkin Dispenser. Shall be designed to dispense standard packaged napkins or tampons, and have flush cabinet door, with two locks, coin box keyed separately, Bobrick B-3500 or approved equal. Dispenser shall be equipped with mechanism for gratis operation.

2.6.05 Sanitary Napkin Receptacles. Recessed sanitary napkin receptacles shall be self-closing, push-in door, and removable stainless steel container with recessed finger grip, Bobrick B-353 or approved equal.

Sanitary napkin receptacles for recessing in metal toilet compartments shall be two self-closing, push-in doors, and stainless steel container with recessed finger grip, removable from one side, and flange adjustable to fit compartment thickness, Bobrick B-354 or approved equal.

2.7 SOAP DISPENSERS.

2.7.01 Surface Mounted Soap Dispenser. Shall be stainless steel vessel with minimum capacity of 40 fluid ounces (1.2 L), unbreakable refill indicator, locked filler top and push-in valve to dispense liquid soap, Bobrick B-4112 or approved equal.

2.8 TOILET PAPER HOLDERS. Shall be chromium-plated brass, chromium-plated steel, or chromium-plated cast aluminum, with stainless steel springs. Double-roll type, Bobrick B-2740 or approved equal.

2.9 SHOWER ACCESSORIES.

2.9.01 Towel Bars. Shall be stainless steel, 7/8 inch (2.2 cm) round towel bar with square or rectangular or round end brackets, 24 inches (61 cm) long, Bobrick B-205 or approved equal.

2.9.02 Shower Curtain Rods. Shall be assemblies of 1-1/4 inch (3.2 cm) outside diameter, 0.050 inch (1.27 mm) thick, stainless steel tubing, complete with end brackets, and length as required to suit conditions, Bobrick B-6047 or approved equal.

2.9.03 Shower Seat. Folding shower seat shall be stainless steel, designed to support 500 pounds (226.8 kg) in fold down position and fold up into wall housing, Bobrick B-521 or approved equal.

2.10 CONSTRUCTION.

2.10.01 Toilet Compartment Sizes. Panels shall be 58 inches (1.5 m) high, set 12 inches (30.5 cm) above floor. Compartment width and doors shall be as indicated on plans.

2.10.02 Doors and Panels. Shall be 1 inch (2.5 cm) thick, constructed of 2 face plates with formed edges, cemented under pressure over the sound deadening core and sealed at all edges (except at anchoring device) with continuous rounded locking strip with corners mitered and welded, welds ground smooth, or with corners internally welded and finished with stainless steel preformed reinforcements. Provide doors and panels with concealed tapping reinforcement for attachment of hardware and accessories where machine screws are required for fastening. Provide smooth surfaces, free from wave, warp or buckle. Provide panels with cutouts for recessed sanitary napkin receptacles and concealed reinforcement for attachment of grab bars.

2.10.03 Pilasters. Shall be 1-1/4 inches (3.2 cm) thick and of same construction as panels.

2.10.04 Fittings. Attach panels and pilasters to one another or to walls, or both, with brackets of approved type.

2.10.05 Hardware. Provide gravity type hinges adjustable to hold door ajar 30 degrees when unlatched. Conceal all operating parts within door. Equip each compartment door with latch, combination stop and keeper fitted with rubber bumper, and combination coat and hat hook and rubber bumper. For attaching hardware, provide machine screws with theft-resistant heads.

2.11 URINAL SCREENS. Shall be wall-hung, bracket-supported type, one inch thick, of same construction as toilet compartment panels, except for both vertical edges of screens, provide additional reinforcement consisting of 4 inch (10.2 cm) wide wood core. Screen size shall be 24 by 42 inches (61 cm by 1.1 m), unless otherwise indicated. Brackets shall be extra heavy gage stirrup brackets with provisions for 2 bolts through screen and 4 holes for attachment of wall anchors.

2.12 FINISH.

2.12.01 Enamel Finish. Thoroughly clean metal surfaces, except chromium-plated, stainless steel or aluminum surfaces, and shop apply a prime coat and finish coat of high grade synthetic enamel, oven-baked to produce a highly mar resistant surface.

2.12.02 Finish Colors. Shall be selected by the Engineer from manufacturer’s full range.

PART 3 - EXECUTION

3.1 INSPECTION. Verify correct spacing of and between plumbing fixtures. Verify correct location of built-in framing, anchorage, and bracing.

3.2 PREPARATION. Protect adjacent construction against damage during progress of this Work.

3.3 INSTALLATION.

3.3.01 General. Erect Work in rigid, substantial manner, straight, plumb, and with horizontal lines level. Install panels with clearance between 1/2 inch (1.3 cm) and one inch (2.5 cm) at wall and fasten by means of at least 2 wall brackets, one located near top and the other near bottom of the panel. Through-bolt each wall bracket to panel and attach to wall with 1/4 inch (6.4 mm) bolts of suitable type. Locate wall brackets so that holes for wall bolts will occur in joints of concrete masonry units or ceramic tile units. Anchor panels to pilasters with stirrup bracket supports matching those at walls.

Conceal evidence of drilling, cutting and fitting of wall, floor and ceiling connections by finished Work. At vertical edges of doors provide uniform clearance from top to bottom, not exceeding 3/16 inch (4.8 mm). Carefully adjust door hardware.

3.3.02 Ceiling Mounted Toilet Compartments. Secure each pilaster to structure above with 1/4 inch (6.4 mm) cadmium-plated screws and lead expansion shields. Provide anchor device which is readily accessible for leveling, plumbing, and tightening the installation.

Fasten toilet and bath accessories securely to walls in accordance with manufacturer's instructions and as approved by the Engineer. Anchor surface-mounted accessories for stud partitions, except bars, to steel sheet reinforcing in the partitions.

Accessory locations and mounting heights above finish floor shall be as indicated or as specified. Coordinate the installation of all accessories, including location preparation of openings for recessed items, to avoid interference with other work.

3.3.03 Grab Bars. Attach concealed anchors for masonry walls with toggle bolts.

Bolt mounting plates to steel plate reinforcing in stud partitions, to expansion shields in concrete walls, to reinforcement in metal partitions, and to thru-bolts welded to back mounting plate, unless otherwise specified. Where back mounting plate on thru-bolts will be exposed to view, anchor the mounting plate to wall with toggle bolts or concealed anchors.

3.3.04 Mirrors. Anchor wall hangers to wall with approved fasteners. Anchor frame to wall hangers with concealed set screws.

3.3.05 Dispensers and Receptacles. Screw cabinets of recessed units to wall recesses.

3.3.06 Surface-Mounted Towel Dispensers. Mounting height shall be 40 inches (1.0 m) to bottom of cabinet.

3.3.07 Sanitary Napkin Dispensers. Unless otherwise indicated, install one sanitary napkin dispenser in each women's toilet room.

3.3.08 Sanitary Napkin Receptacles. Unless otherwise indicated, install one sanitary napkin receptacle in each water closet compartment in women's toilet rooms.

3.3.09 Toilet Paper Holders. Mounting height shall be 34 inches (86.4 cm) to center of holder. Unless otherwise indicated, install one toilet paper holder in each water closet compartment in all toilet rooms.

3.4 SHOWER ACCESSORIES.

3.4.01 Shower Accessory Mounting Heights. Towel bars shall be 49 inches (1.2 m) to center of bar. Curtain rods shall be 74 inches (1.9 m) to center of rod.

3.5 MAINTENANCE.

3.5.01 Cleaning. Clean finished surfaces in accordance with manufacturer's instructions. Leave the Work free of imperfections.

End of Section

SECTION 10200

LOUVERS AND GRILLES

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous louvers and grilles.

1.2 GENERAL.

1.2.01 Coordination. Coordinate the Work with installation of masonry flashings, mechanical ductwork, and electrical services to motorized devices.

1.2.02 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

AMCA (Air Movement and Control Association) 500 – Test Method for Louvers, Dampers, and Shutters.

ASTM (American Standard Testing Material) A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.

ASTM A666 – Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM B209/B209M – Specification for Aluminum-Alloy Sheet and Plate.

ASTM B221/B221M – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) "Architectural Sheet Metal Manual"

UL (Underwriters Laboratories, Inc.) – Electrical Construction Materials Directory.

1.3 QUALITY ASSURANCE. Comply with SMACNA (Sheet Metal and Air Conditioning Contractor's National Association) "Architectural Sheet Metal Manual" recommendations for fabrication, construction details, and installation procedures, except as otherwise indicated.

1.3.01 Manufacturer's Qualifications. Company shall have a minimum of five years documented experience manufacturing products specified in this section.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings for the fabrication and erection of louver assemblies. Include layout plan and elevations, details of sections and connections. Show anchorage items.

Submit manufacturer's technical data, including maximum recommended air velocity, design free area, anchor details and installation instructions including finishing products. Submit installation instructions and provide to the installer. Submit operation and maintenance data for the installed louvers and grilles.

1.4.02 Certifications. Certify that louvers and grilles furnished meet or exceed specified SMACNA requirements and other requirements specified in this section.

1.4.03 Samples. Submit 2 samples, 6 inch (15.2 cm) square, of each type of metal finish to be used in the Work. Prepare samples on metal of the same gage and alloy to be used in the work. Samples will be reviewed for color and texture only. Compliance with all other requirements is the exclusive responsibility of the Contractor.

1.5 WARRANTY. Provide ten year manufacturer warranty for louvers. Include coverage for degradation of flouropolymer finish.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide products of one of Airline Products Co., Greenheck Corp, Industrial Louvers, Inc., or an approved equal.

2.2 MATERIALS.

2.2.01 Aluminum Sheet. Shall be ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by the metal producer to provide the required finish.

2.2.02 Aluminum Extrusions. Shall be ASTM B 221, Alloy 60603 - T52.

2.2.03 Fastenings. Use same material as items fabricated, unless otherwise indicated. Fasteners for exterior applications may be hot-dip galvanized, stainless steel or aluminum. Provide types, gages and lengths to suit unit installation conditions. Use Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

2.2.04 Finish. All exposed interior and exterior aluminum surfaces shall receive a fluoropolymer coating (70 percent Kynar) applied in a minimum of 3 coats. The coating shall comply with AAMA 605.2 requirements. A maximum of three colors will be selected from the manufacturer's full line of colors by the Engineer.

2.2.05 Anchors and Inserts. Use non-ferrous metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.2.06 Bituminous Paint. Shall be SSPC-Paint 12 (cold-applied asphalt mastic).

2.3 EXTRUDED ALUMINUM LOUVERS. Furnish extruded aluminum louvers, with extrusions not less than 0.081 inches (2.1 mm) thick, of size indicated. Fabricate frames to suit adjacent construction. Assemble louvers and provide all supports, anchorages and accessories for complete installation. Locate sills where shown, of the same material and thickness as louvers.

2.4 SCREENS. Provide removable screens for exterior louvers. Fabricate screen frame of the same metal and finish as the louver units to which secured.

Provide frames consisting of u-shaped metal for permanently securing screen mesh.

Use 1/2 inch square (12.7 mm sq) mesh, 0.064 inch (1.63 mm) anodized aluminum wire bird screen.

Locate screens on inside face of louvers. Secure screens at Louver frames with machine screws, spaced at each corner and at 12 inch (30.5 cm) o.c. between.

2.5 MANUFACTURE AND FABRICATION. Verify size, location and placement of louver units prior to fabrication wherever possible. Coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustment, splicing mechanical joints and field assembly of units. Preassemble units in as large of sections as practicable.

2.5.01 Louver Blade Design. Sloped at 45 degrees reinforced with intermediate stiffeners, with integral and lateral rain water stops positioned on blade unless indicated otherwise.

2.5.02 Intermediate Mullions. Concealed of extruded aluminum, profiled to suit louver frame.

2.5.03 Head and Sill Flashings. Install head and sill flashings extruded to required shape, single length in one piece per location.

2.5.04 Screens. Install screen mesh in shaped frame, reinforce corner construction.

PART 3 - EXECUTION

3.1 INSPECTION. Installer must examine the areas and conditions under which louvers and associated items are to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer and Engineer

3.2 PREPARATION. Coordinate setting drawings, diagrams, templates, instructions and directions for the installation of anchorages which are to be embedded in concrete or masonry construction. Coordinate the delivery of such items to the project site.

3.3 INSTALLATION. Locate and place louver units plumb, level and in proper alignment with adjacent work. Use concealed anchorages wherever possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint filler, as indicated.

Repair finishes damaged by cutting, welding, or grinding operations required for fitting and joint. Restore finishes and prime coats of paint so that there is no evidence of corrective work. Return items which cannot be refinished in the field to the shop, make the required alterations, and refinish the entire unit, to provide new units, at Contractor's option.

Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry or dissimilar metals. Provide concealed gaskets, flashing, joint fillers, caulking, insulation, and install as the work progresses to make the installations weathertight. Refer to Master Specification Section 07600, Caulking and Sealers for caulking of louvers.

3.3.01 Adjusting. Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

3.2.02 Cleaning. Clean surfaces and components.

End of Section

SECTION 10300

VISUAL DISPLAY BOARDS

PART 1 - GENERAL

1.1 SCOPE. This section covers various types of display boards, including projection screens, marker boards and tack boards..

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

AHA (American Hardboard Association) A135.4 – Specification for Basic Hardboard.

ANSI (American National Standards Institute) A208.1 – Specification for Wood Particleboard.

ASTM (American Society for Testing and Materials) A424 – Specification for Steel Sheets for Porcelain Enameling.

ASTM A653/A653M – Specification for Steel Sheets, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

ASTM B209 – Specification for Aluminum-Alloy Sheet and Plate.

ASTM B221 – Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.

ASTM C36 – Specification for Gypsum Wallboard.

ASTM C208 – Specification for Cellulosic Fiber Insulation Board.

ASTM E84 – Test Method for Surface Burning Characteristics of Building Materials.

FS (Federation Specifications.) CCC-W-408 – Specification for Wall Covering, Vinyl-Coated.

FS L-P-1040 – Specification for Plastic Sheets and Strips (Polyvinyl

Fluoride).

1.3 QUALITY ASSURANCE. Conform to Fed. Spec. CCC-W-408A for flame/smoke rating for vinyl fabric covered tackboards in accordance with ASTM E84.

1.3.01 Manufacturer's Qualifications. Company shall have a minimum of five years documented experience specializing in manufacturing products specified in this section.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Indicate wall elevations, dimensions, joint locations, and special anchor details. Submit product data on chalkboards, markerboards, trackboards, trackboard surface covering, and trim and accessories. Submit Operation and Maintenance data.

1.4.02 Samples. Submit two samples each 4 x 4 inch (101.6 mm x 101.6 mm) in size illustrating materials and finish, color and texture of chalkboard, markerboard, chalkboard and trim, tackboard, and tackboard surfacing.

1.5 DELIVERY, STORAGE, AND HANDLING. All parts and assemblies shall be protected during fabrication, shipment, storage, and erection to prevent damage. Damaged units will be rejected and shall be replaced at no additional cost to the Owner.

1.6 WARRANTY. Provide two-year manufacturer warranty for visual display boards. Chalkboard and markerboard surface shall be warranted against discoloration due to cleaning, crazing or cracking, and staining.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide products of Alliance America, Best-Rite Chalkboard Co. Inc., Claridge Products and Equipment, and Marsh Industries Inc., or an approved equal.

2.2 MATERIALS.

2.2.01 Sheet Steel. Shall be ASTM A424, Type I, commercial quality.

2.2.02 Aluminum Sheet. Shall be ASTM B209 6063-T4 alloy.

2.2.03 Hardboard. Shall be AHA A135.4, Tempered type, with pretreated surface for chalkboard paint.

2.2.04 Cork. Shall be fine grain natural cork, homogeneous composition.

2.2.05 Composition Cork. Shall be formulation of cork granules, oils, pigments, and urea formaldehyde plastic, color as selected by Owner.

2.2.06 Tackboard Covering. Shall be vinyl coated fabric roll stock.

2.2.07 Hardboard. Shall be AHA A135.4, tempered, smooth face.

2.2.08 Particle Board. Shall be NPA A208.1, wood chips, or shavings set with waterproof resin binder, sanded faces.

2.2.09 Foil Backing. Shall be aluminum foil sheet.

2.2.10 Frame and Chalkrail. Shall be aluminum extrusions, ASTM B221, 6063-T5 alloy.

2.2.11 Marker Boards. Marker board panels shall have an LCS white liquid chalk porcelain-enameled writing surface. All panels shall be factory-mounted on tempered hardboard or other suitable backing as recommended by the manufacturer. Each unit shall have a clear, anodized aluminum surrounding frame with square corners, and each marker board shall have an attached marker tray.

2.3 ACCESSORIES.

2.3.01 Adhesives. Use a type approved by manufacturer.

2.3.02 Map Supports. Shall be formed aluminum sliding hooks or roller brackets to fit map rail.

2.3.03 Flag Holders. Shall be cast aluminum or formed steel bored to receive 1 inch (25.4 mm) diameter flag staff, bracketed to fit top rail of chalkboard, marketboard, or trackboard.

2.3.04 Cleaning Instruction Plate. Provide instructions for chalkboard cleaning on a plastic plate fastened to perimeter frame.

2.4 PROJECTION SCREEN.

2.4.01 Manufacturers. Provide product from Da-Lite Screen Company, Inc.; Draper shade & screen Co., Inc., or approved equal.

2.4.02 Fabrication. Screen surface shall be matte white surface with 2 inch (5.1 cm) black masking borders, 60 x 60 inch (1.5 m x 1.5 m) size, unless otherwise indicated, mounted on 3 inch (7.6 cm) steel roller. Case shall be 22 gage (0.85 mm) steel with flat back, finished with baked enamel finish, fitted with end caps and wall mounting brackets.

PART 3 - EXECUTION

3.1 INSPECTION. Verify internal wall blocking is ready to receive Work and positioning dimensions are as indicated on shop drawings or as instructed by the manufacturer. Verify flat wall surface for frameless adhesive applied type.

3.2 PREPARATION. Protect the Work and adjacent construction against damage during installation.

3.3 INSTALLATION. Install each visual display board or projection screen in accordance with manufacturer's instructions, approved shop drawings and specified requirements. Furnish each item with required fasteners.

Anchor projection screens to the wall with 3/8 inch (9.5 mm) toggle bolts at an elevation of 8 feet, 6 inches (2.6 m) above finish floor, unless otherwise indicated.

3.4 CLEANING. Upon completion, clean the Work in accordance with manufacturer's instructions.

End of Section

SECTION 10400

MARKER POSTS AND SIGNAGE

PART 1 - GENERAL

1.1 <u>SCOPE</u>. This section includes fabricated marker posts and interior and exterior signage.

1.2 <u>GENERAL</u>.

1.2.01 <u>Governing Standard</u>. Unless otherwise specified, the work of this section shall conform to the application portions of the following:

> ASTM (American Society for Testing and Materials) A120 – Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe For Ordinary Uses.
>
> Federal Highway Administration's <u>Manual on Uniform Traffic Control Device</u>.
>
> American Association of State Highway and Transportation Officials <u>Standard Specifications for Structural Supports for Highway Signs</u>.
>
> The Building Officials and Code Administrators (BOCA) <u>National Building Code</u>.

1.3 <u>QUALITY ASSURANCE</u>.

1.3.01 <u>Manufacturer's Qualifications</u>. Manufacturer shall have a minimum of five years of documented experience specializing in manufacturing sign products specified in this section.

1.3.02 <u>Field Measurements</u>. Take field measurements prior to preparation of shop drawings and fabrication where necessary to ensure proper fitting. Show recorded measurements on final shop drawings.

1.4 <u>SUBMITTALS</u>.

1.4.01 <u>Drawings and Data</u>. Show fabrication and erection of signs. Include plans, elevations, and large-scale sections of typical members and other components. Show anchors, grounds, layout, reinforcement, accessories, and installation details.

Submit data to Engineer for each type of sign specified, including details of construction relative to materials, dimensions of individual components, profiles, and finishes.

Provide message list for each sign required, including large-scale details of wording and lettering layout.

For signs supported by or anchored to permanent construction, provide setting drawings, templates, and directions for installation of anchor bolts and other anchors to be installed as a unit of work in other sections.

1.4.02 Samples. Submit to Engineer manufacturer's full range of samples for initial selection of signage color, pattern, and texture. Submit for approval, one sample of each type of sign or marker post. The Contractor shall clearly label each sample submittal including project title and number.

Furnish full-size spacing templates for individually mounted dimensional letters and numbers.

1.5 DELIVERY, STORAGE, AND HANDLING. Package signs, labeled in name groups. Package and handle all markers, signs, and accessories to prevent damage or marring during transportation, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Marker Posts. Steel pipe for marker posts shall conform with ASTM A120, Schedule 40. Furnish each post with a 10 gauge (3.5 mm) steel cap, flush welded. Concrete for post encasement shall conform with Master Specification Section 03300, Cast-in-Place Concrete.

2.1.02 Aluminum Sheet. Alloy and temper shall be as recommended by the sign manufacturer for the type of use and finish indicated, and with not less than the strength and durability properties specified in ASTM B209 for 5005-H15.

2.1.03 Aluminum Castings. Alloy and temper shall be as recommended by the sign manufacturer for the casting process used and for the use and finish indicated.

2.1.04 Metal Fasteners. Use metals that are not corrosive to the sign material or mounting surface.

2.1.05 Anchors and Inserts. Use nonferrous metal or hot-dipped galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

2.2 MANUFACTURE AND FABRICATION.

2.2.01 Graphic Content and Style. Provide sign that complies with the requirements indicated for size, style, spacing, content, position, material, finishes, and colors of letters, numbers, and other graphic devices.

Exterior building signage shall be cast aluminum letters as detailed on building elevations, with anodized finish as described below.

2.2.02 Finishes. Provide color match charts to Engineer for exposed sign material that requires selection of materials with integral or applied colors, surface textures or other characteristics related to appearance. Where not indicated, color will be as selected by the Engineer.

Metal Finishes shall comply with NAAMM Metal Finishes Manual for finish designations and applications recommendations. Aluminum finish designations shall be prefixed by "AA" and conform to the system established by the Aluminum Association for designating aluminum finishes. Color anodized finishes shall be medium satin AA-M31C22A32. Baked-enamel finishes shall be A-M4xC12C42R1x. Apply baked enamel in compliance with paint manufacturer's specifications for cleaning, conversion coating, and painting. Organic coating shall be thermosetting-modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with a minimum dry film thickness of 1.5 mils (0.04 mm), medium gloss.

2.2.03 Marker Post Painting. Prior to painting, all exposed galvanized surfaces shall be thoroughly cleaned of all dirt, oil, grease, and other foreign matter.

Only surfaces that are not to be encased in concrete shall be painted. Before any paint is applied, the galvanized areas to be painted shall be chemically treated thoroughly with “Lithoform,” “Galvaprep,” or approved equal in order to ensure that the paint will firmly bond with the surface it is applied to.

Prime coat shall be a zinc-dust primer such as “Speedhide Galvanized Steel Primer,” Number 6-215/216, color grey, as manufactured by Pittsburgh Plate Glass Company or approved equal.

After the prime coat is thoroughly dry, there shall be applied two finish coats of “Dulux” Matching Number 181-15666, color Surf Blue, as manufactured by DeNemours E.I. DuPont and Company or approved equal.

All paints shall be applied only as recommended by the manufacturer. Paints may be applied by brush or spray provided that each coat forms a uniform film without runs, snags, or brush marks.

After installation, the Contractor shall touch-up any marks or abrasions to the satisfaction of the Engineer.

General contractor shall provide temporary signs for exterior building sign Type “A” painted on ¾” thick exterior grade plywood surfaces for owner/architect approval

2.2.04 Interior Signage System. The interior signage system shall be ASI “SP” series as manufactured by ASI Sign Systems, Inc., with 0.080 inch (2.0 mm) laminated back plate style “SPF”. Mounting shall be on the door surface unless scheduled otherwise. Signs shall be square cornered and shall have a semi-matte low luster finish.

Colors of the field and lettering shall be selected from the manufacturer’s standard colors by the Owner. Size of the signs shall be a minimum 6 inch (15.2 cm) square and larger as required by the typography.

Lettering shall be Helvetica Medium Ultra Condensed of the sizes scheduled herein. Lettering shall be upper and lower case.

Furnish room identification signage in accordance with the signage schedule, and with designated room names and numbers as provided by the Owner. Signs for installation on glass shall be provided with matching backing plate for application to the reverse side of the glass.
Provide mechanical signs/labels as per DWSD standard master specification Division 15.

2.2.05 Exit Signage. “Exit” signs shall have red letter at least 6 inches (15.2 cm) high and the minimum width of each stroke shall be 3/4 inch (19 mm) on a white background or in other approved distinguishable colors. The word “Exit”, except the letter “i”, shall have letters having a width of not less than 2 inches (51 mm) and the minimum spacing between letters shall not be less than 3/8 inch (10 mm). Signs larger than the minimum size herein required shall have letter widths and spacing in the same proportions to the heights as indicated in this section. If an arrow is provided as part of an “Exit” sign, the construction shall be such that the arrow direction cannot be readily changed. The word “Exit” shall be clearly discernible when the sign illumination means is not energized.

Each sign shall be illuminated by a source providing not less than 5 footcandles (54 lux) at the illuminated surface and shall have a contrast ratio of not less than 0.5. As an exception, approved self-illuminated letters shall have a minimum luminance of

0.06 foot lamberts (0.21 cd per sq m) Primary power shall be provided to signs in accordance with Master Specification Division 16, Electrical.

All “Exit” signs shall be illuminated at all times that building is occupied. To assure continued illumination for a duration of not less than 1 hour in case of primary power loss, the “Exit” signs shall be connected to an emergency electrical system except where approved self-luminous signs are used and provide continuos illumination independent of external power sources.

2.2.06 Safety and Warning Signs. Safety and warning signs and labels shall be furnished and installed to indicate and define hazards, which may lead to accidental injury to personnel or to property damage. The signs and labels shall be constructed of laminated plastic. The sign size, shape, and color shall be in accordance with the Occupational Safety and Health Act (OSHA), Federal Register Part 2, Paragraph 1910.45.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 Sign Placement. Install room identification signage in accordance with the signage schedule, and with designated room names and numbers as provided by the Owner.

Mount sign units and accessories where indicated, using methods described and in compliance with the manufacturer's instructions. Install signs level, plumb, and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

Dimensional letters and numbers shall be mounted using standard fastening methods recommended by the manufacturer for the sign or lettering type, wall construction, and condition of exposure indicated.

For individual lettering, provide heavy paper template to establish letter spacing and to locate holes for fasteners. For flush mounting, mount letters with backs in contact with the wall surface.

3.1.02 Marker Post Installation. Marker posts shall be placed on the same side of the right-of-way as the main is located, laterally opposite the appurtenance, and transversely 1 foot inside the right-of-way or property line unless otherwise directed by the Engineer.

Marker posts opposite structures located in gravel surface roads, where the frame cover is set 15 inches (38.1 cm) below grade, shall have a 3 inch by 4 inch (7.6 cm by 10.2 cm) stainless steel plate (ASTM 304) placed 3 inches (7.6 cm) from top of post and secured to the post with stainless steel machine screws. The plate shall indicate the structure type and distance(s), direction(s), and offset(s) to the structures. The lettering on the plate shall be block 1/4 inch (6.4 mm) engraved block lettering. Details of the plate shall be submitted for approval prior to fabrication.

In cultivated lands, the marker post shall be installed opposite the appurtenance and as close to a fence line as possible where directed by the Engineer.

In residential areas, where three or more appurtenances are located within a total length of 200 feet (61 m) or less, marker posts shall be placed opposite one appurtenance selected by the Engineer.

3.1.03 Interior Sign Mounting. Interior signs shall be mounted as specified and as recommended by the manufacturer at the locations indicated. Mounting methods shall be appropriate for the mounting surface available. Signs shall be installed square and level at the height designated. Signs shall be door-mounted unless noted otherwise.

3.1.04 Installation of Exit Signage. In all buildings, rooms, or spaces required to have more than one exit or exit access, all required means of egress shall be indicated with approved signs reading “Exit”. The “Exit” signs shall be visible from the exit access and, where necessary, supplemented by directional signs in the exit access corridors indicating the direction and way of egress. All “Exit” signs shall be located at exit doors or exit access areas, so as to be readily visible. Sign placement shall be such that any point in the exit access shall not be more than 100 feet (30.5 m) from the nearest visible sign.

As an exception, main exterior exit doors which are obviously and clearly identifiable as exists are not required to have “Exit” signs where approved.

3.1.05 Cleaning. After installation, clean soiled sign surfaces according to the manufacturer's instructions. Protect units from damage until acceptance by the Owner.

End of Section

SECTION 10522

FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This Section includes furnishing portable fire extinguishers, fire extinguisher cabinets, and related accessories.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified the work of this section shall conform to the applicable portions of the following:

NFPA (National Fire Protection Association) 10 – Standard for Portable Fire Extinguishers.

UL (Underwriters Laboratories, Inc.) – Fire Protection Equipment Directory.

1.3 QUALITY ASSURANCE. Provide only fire extinguishers which comply with NFPA 10.

1.3.01 Labels. Provide only fire extinguishers, and fire extinguisher cabinets which are listed and labeled by Underwriters Laboratories Inc., or Factory Mutual System. Do not use permanent fire extinguishers for protection during construction period.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Provide drawings showing location of extinguishers, cabinets and applicable dimensions. Also submit manufacturer's data showing compliance with contract documents, color, finish and anchorage details. Submit manufacturer’s installation instructions. Provide maintenance data, including recommended cleaning, testing and recharging methods and materials.

1.4.02 Certifications. Installer shall submit written certification that the fire extinguishers installed comply with the contract documents and are fully and correctly charged.

1.4.03 Samples. Provide samples showing finishes of cabinets, on actual or similar material.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Products of the following manufacturers, or others that are equal, provided they comply with requirements of contract documents, will be among those considered acceptable:

2.1.01 Fire Extinguishers.

Ansul Incorporated
Grinnell Corp.
JL Industries
Larsen's Manufacturing Co.
Nystrom Products Co.
Cosmic
ABC Dry Chemical

2.1.02 Cabinets and Accessories.

Ansul Incorporated
Grinnell Corp.
JL Industries
Larsen's Manufacturing Co.
Nystrom Products Co.

2.2 FIRE EXTINGUISHERS. Provide fire extinguishers with cabinets or without in the quantities and sizes indicated on the drawings. Where indicated, provide such additional extinguishers in accordance with the instructions, requirements and recommendations of all applicable Governing Codes, Regulations and Standards.

2.2.01 Dry Chemical Type. Shall be stainless steel or cast steel tank, with pressure gage; size and classification as indicated on the drawings.

2.2.02 Foam Type. Shall be stainless steel or cast steel tank, with pressure gage, size and classification as indicated on the drawings.

2.2.03 Carbon Dioxide Type. Shall be stainless steel or cast steel tank, with pressure gage; size and classification as indicated on the drawings.

2.2.04 Extinguisher Finish. Shall be stainless steel, satin chrome or enamel finish.

2.3 CABINETS AND CABINET ACCESSORIES.

2.3.01 Metal. Shall be formed stainless steel or as indicated on the drawings.

2.3.02 Style. Shall be recessed mounted, with overlapping 2 1/2 inch (6.4 cm) return trim, single flat door flush with trim.

2.3.03 Door Material. Shall be stainless steel, satin finished, and with surface mounted door handle, finished to match door.

2.3.04 Trim (box flange or frame). Shall be same material and finish as door with no lettering on door or trim.

2.3.05 Box. Shall be manufacturer's standard material and construction.

2.3.06 Hinges. Provide hinges for each door, concealed or continuous type that allow full 180 degree opening of door. Finish exposed hinges to match door.

2.4 ACCESSORIES.

2.4.01 Fire Blanket. Shall be fire retardant treated material. The color and size to be chosen by Owner.

2.4.02 Extinguisher Brackets. Provide brackets suitable for extinguishers made of compatible materials.

2.4.03 Cabinet Signage. Provide signage as indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECTION. Verify the intended mounting surfaces and openings are ready to receive the work. Verify field measurements are as on shop drawings.

3.2 PREPARATION. Clean substrate surfaces. Protect elements surrounding the work of this Section from damage or disfiguration. Prepare openings for recessed cabinets.

3.2.01 Keys for Cabinet Locks. Obtain the Owner's instructions as to the keying scheme required. Do not deliver or install extinguishers until just before substantial completion.

3.3 INSTALLATION. Perform installation in accordance with the manufacturer's instructions except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of the work. Install cabinets and extinguishers at locations and heights indicated, in accordance with NFPA. Deliver keys to owner at substantial completion.

3.3.01 Cleaning. Clean the work in accordance with Master Specification Section 01190, Contract Closeout and Cleaning and clean the exposed surfaces of all components.

End of Section

SECTION 10700

STORAGE SHELVING, PARTITIONS, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section includes miscellaneous shelving, partitions, and all associated accessories.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Maintain spaces to receive the Work at a temperature of at least 65 degrees F (18 degrees C). Install materials only when normal temperature and humidity conditions approximate the interior conditions that will exist when the building is occupied.

1.2.02 Governing Standards. Unless otherwise specified, the work of this section will conform to the applicable portions of the following standard specifications:

AA (Aluminum Association) DAF-45 - Designation System for Aluminum Finishes.

AA SAA-46 - Specification for Anodized Architectural Aluminum.

ASTM (American Society for Testing and Materials) A36 – Specification for Carbon Structural Steel.

ASTM A53/A53M – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

ASTM A123 – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

ASTM A500 – Specification for Cold-formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A501 – Specification for Hot-formed Welded and Seamless Carbon Steel Structural Tubing.

ASTM A510 – Specification for General Requirement for Wire Rods and

Course Round Wire, Carbon Steel.

ASTM A580 – Specification for Stainless and Heat-Resisting Steel Wire.

ASTM A1008-01 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM B211 – Specification for Aluminum-Alloy Bars, Rods, and Wire.

ASTM B221/B221M – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

ASTM C847 – Specification for Metal Lath.

ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.

ASTM E90 - Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

AWS D1.1 – Structural Welding Code.

FS QQ-W-461 – Wire, Steel, Carbon (Round, Bare, and Coated).

FS TT-P-31 – Paint, Oil, Iron Oxide, Ready Mix, Red and Brown.

FS TT-P-641 – Primer Coating, Zinc Oxide (for Galvanized Surfaces).

FS TT-P-645 – Primer, Paint, Zinc Chromate.

NEMA (National Electrical Manufacturers Association) LD 3 - High-Pressure Decorative Laminates.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor's Qualifications. Employ manufacturer, or his authorized representative as approved by the Engineer, to install the Work with the use of workmen skilled in the trade.

1.3.02 Manufacturer's Qualifications. Company shall have five years documented experience in manufacturing the products specified in this section.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings depicting all the shelving and partition system layouts. Drawings shall include walls, ceilings, gates, accessories, interruptions, special sized panels, appurtenances, edge details, elevation differences, stairs, ramps, plan and vertical dimensions, elevations, component details, head, jamb and sill details, and the location of hardware. Drawings shall show all framed openings, bearing and anchorage points and loadings, welds, types and locations of fasteners and accessories, and all items required for related work.

Provide design analysis, fabrication and installation calculations for all shelving and partition system loadings, stresses, material size and shape selections, bearing and anchorage point loadings. Information shall be prepared, sealed and signed by a design professional having the appropriate discipline education, training, and experience, and currently registered in State of Michigan.

Provide product date for all shelving and partition system components, including screen materials. Furnish maintenance instructions for finishes and operating components.

1.4.02 Certifications. Submit a statement of compliance for performance requirements.

1.4.03 Samples. Submit samples for the purpose of selecting finishes of all the shelving and partition systems construction and components, including samples of posts, post heads, brackets, anchors, rails, frames, panels, gates, hinges, latches and locksets, clearly depicting the work that will be provided, including style, color, and finish.

1.5 DELIVERY, STORAGE, AND HANDLING. Protect the Work from damage during transportation to the Project site, storage at the site, and progress of the Work until completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Provide folding partitions having the following minimum performance requirements when tested in accordance with the applicable test method by a testing laboratory approved by the Engineer:

Sound transmission class for sound insulating partitions: 50 per ASTM E90, in large scale opening 14 feet (4.3 m) by 9 feet (2.7 m), incorporating standard irregularities.

Fire hazard classification of facing material: maximum 25 for flame spread and 50 for smoke developed per ASTM E84.

2.2 MATERIALS.

2.2.01 Fiberboard. Shall be 7/16 inch (11 mm) thick mineral backing as manufactured by Conwed Corp. or Simpson Timber Co., having maximum fire hazard classification of 25 for flame spread and 50 for smoke developed, when tested in accordance with ASTM E84.

2.2.02 Fabric. Shall be GF Business Equipment Co. panel fabric no. "G3A Roan".

2.2.03 Vinyl Fabric. Forbo Industries, Inc. "Vicrtique", "Loba" pattern in color selected by the Engineer from manufacturer's standard range, or as approved, complying with the following:

Backing weight: 4.2 oz. per sq. yd. (142 g per sq m) average.

Coating weight: 10.8 oz. per sq. yd. (366 g per sq m) average.

Total weight: 15.0 oz. per sq. yd. (508 g per sq m) average.

Backing type: non-woven polyester.

Tensile strength (W x F): 150 x 130 lbs. (667 x 578 N).

Tear strength (Elmendorf W x F): 100 x 100.

Color fastness (200 hours fadometer): no change.

Shrinkage (W x F): 1.7 x 0.5 percent average.

Noise reduction coefficient: 0.15.

Adhesive for laminating vinyl fabric to fiberboard shall be as recommended by manufacturer of vinyl fabric.

2.2.04 Plastic Laminate. Shall meet NEMA publication LD3 for general purpose type. Plastic laminate face sheet shall be 0.028 inch (0.71 mm) thick with low-gloss finish; Formica Corp. "Formica"; Nevamar Div. of International Paper Co. "Nevamar"; International Paper Co. "Micarta"; Wilsonart International "Wilsonart"; or as approved; in solid patterned color as selected by the Engineer from manufacturer's standard range.

2.2.05 Aluminum. Extruded aluminum shall comply with ASTM B221, 6063 alloy. Aluminum for hard anodic finish shall be the alloy required to produce the specified finish, temper as recommended by the manufacturer.

2.2.06 Framing Members. Shall be ASTM A36, formed steel sections.

2.2.07 Chain Link Fabric. Shall be 2 inch (5.1 cm) diamond mesh galvanized steel wire, interwoven, 6 gage thick, top salvage twisted tight, bottom salvage knuckle end closed; including tension bars, tension wire, and accessories.

2.2.08 Welding Materials. Shall be AWS D1.1; type required for materials being welded.

2.2.09 Bolt, Nuts and Washers. Shall be hot dip galvanized.

2.2.10 Anchorage Devices. Shall be drilled expansion bolts.

2.2.11 Exposed Mechanical Fastenings. Shall be flush countersunk screws or bolts, unobtrusively located, consistent with design of structure.

2.3 INDIVIDUAL FOLDING PANEL PARTITION.

2.3.01 Manufacturers. Product shall be Hufcor, Inc. "Series 6600"; Modernfold, Inc. "Acousti-Seal 931"; Panelfold, Inc. "Model 610"; or approved equal.

2.3.02 Operation. Partition shall be a series of individual panels, manually operated, top supported, with operable floor seals. Final closure shall be accomplished with a horizontally expanding panel.

2.4 PAIRED FOLDING PANEL PARTITION.

2.4.01 Manufacturers. Product shall be Hufcor, Inc. "Series 6500"; Modernfold, Inc. "Acousti-Seal 932"; Panelfold, Inc. "Model 620"; or approved equal.

2.4.02 Operation. Partitions shall be a series of panels hinged in groups of two, manually operated, top supported, with operable floor seals. Final closure accomplished with a horizontally expanding panel.

2.5 CONTINUOUSLY HINGED FOLDING PARTITION.

2.5.01 Manufacturers. Product shall be Hufcor, Inc. "Series 6900"; Modernfold, Inc. "Acousti-Seal 933"; Panelfold, Inc. "Model 630"; or approved equal.

2.5.02 Operation. Product shall be series of continuously hinged panels, manually operated, top supported, with operable floor seals that drop automatically with final closure. Final closure accomplished with a hinged closure panel.

2.6 MANUFACTURE AND FABRICATION.

2.6.01 Partition Panel Construction. Shall be sound insulation core construction 3 5/8 inches (92 mm) thick with facing of vinyl fabric laminated with adhesive to fiberboard and extruded aluminum frame, with provision for replacing panel facing in field. Equip lead panels and panels abutting pocket doors with a self-adjusting, telescoping vertical seal.

2.6.02 Partition Suspension System. Partition top shall be supported by an extruded aluminum overhead track with bolted connection to steel framing or insert embedded in concrete, with provision for leveling during installation and access for future adjustment.

Each panel shall be supported by a vertical duplex carrier system consisting of a pair of 4-wheel steel race, nylon tired, ball bearing carriers which travel within the panel race from center of panel when stacked to lead edge of panel when extended.

2.6.03 Pocket Doors. Shall be a minimum of 3 inch (76 mm) thick sound insulation core construction with hardwood stiles and rails, with facing of vinyl fabric.

Provide required hardware, including hinges, flush pulls and bolts, as approved. Provide sound seal at floor and head.

2.6.04 Trim. Soffit trim shall be extruded aluminum.

2.7 WIRE MESH PARTITIONS. Fabricate assemblies of framed sections; to sizes and profiles required; with framing members fitted, reinforced and braced to suit design requirements. Fit and assemble in largest practical sections for delivery to site, ready for installation. Fabricate items with joints tightly fitted and secured. Grind exposed welds flush and smooth with adjacent finish surface. Ease exposed edges to small uniform radius. Make exposed joints flush and hairline.

Provide components required for anchorage to metal fabrications. Fabricate anchorage and related components of same materials and finish as framing members.

2.8 FINISHES.

2.8.01 Hard Anodic Finish. Anodize aluminum exposed to view to produce an AA-M12C22A42 hard anodic finish, unless otherwise specified, in accordance with AA DAF-45 and AA SAA-46. Color selection shall be determined by Owner.

2.8.02 Clear Anodic Finish. Anodize aluminum exposed to view to produce an AA-M12C22A31 clear anodic finish in accordance with AA DAF-45 and AA SAA-46.

2.8.03 Finish for Hardware. B.H.M.A. Code 626 (US26D satin chromium-plated) or 630 (dull stainless steel).

2.9 ACCESSORIES.

2.9.01 Bracing. Shall be formed sheet steel, thickness determined for conditions encountered, manufacturer’s standard shapes, same finish as framing members.

2.9.02 Plates, Gussets, Clips. Shall be formed sheet steel, thickness determined for conditions encountered, manufacturer’s standard shapes, same finish as framing members.

2.9.03 Touch-up Primer for Galvanized Surfaces. Shall be FS TT-P-641.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that surfaces and openings are ready to receive work. Verify field measurements are as shown on shop drawings. Beginning of installation shall mean installer accepts existing conditions.

3.2 PREPARATION. Clean substrate surfaces. Protect adjacent construction against damage during progress of the Work.

3.3 INSTALLATION. Install shelving and partitions in accordance with manufacturer's instructions and approved Shop Drawings. Install items plumb and level, accurately fitted, free from distortion or defects. Perform field welding in accordance with AWS D1.1. After installation, touch-up scratched or damaged surfaces with primer.

3.3.01 Cleaning. Thoroughly clean partition and other surfaces in accordance with manufacturer's instructions. Remove temporary protection from pre-finished surfaces.

3.4 FIELD QUALITY CONTROL.

3.4.01 Acceptance Tests. Before Owner’s acceptance, demonstrate to the Engineer’s satisfaction that folding partitions are free moving and operate smoothly and evenly. Make all final adjustments as may be necessary to obtain proper operations of the Work.

End of Section

SECTION 10800

LOCKERS

PART 1 - GENERAL

1.1 SCOPE. This section covers metal lockers and benches including all accessories and appurtenances.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified, the work of this section shall conform to the applicable portions of the following standard specifications:

> ASTM (American Standard Testing Materials) A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

1.3 QUALITY ASSURANCE. Employ the metal locker manufacturer or his authorized representative to install the work using workmen skilled in the trade.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings indicating layout, dimensions, and other pertinent construction and erection details.

Submit manufacturer's installation instructions with installation template and attachment devices.

1.4.02 Samples. Submit samples of manufacturer's full range of painted finishes.

1.4.03 Record Drawings. Furnish receipts for keys for keyed lockers.

1.5 DELIVERY, STORAGE AND HANDLING. Protect the Work from damage during transportation to the Project site, storage at the site, and during progress of the work until completion.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Take field measurements to verify and supplement dimensions indicated. Be responsible for accurate fit of the Work.

2.2 ACCEPTABLE MANUFACTURERS. Provide product of Interior/Medart; Lyon Metal Products, Inc.; Penco Products; Republic Storage Systems Co., Inc.; or an approved equal.

2.3 LOCKER TYPES.

2.3.01 Double Tier Lockers. Standard louvered doors with 2 point locking device, flat top, compartment divider, equipped with 3 single-prong coat hooks and one double-prong ceiling coat hook for each compartment. Unless otherwise indicated, width x depth x height per compartment shall be 12 x 12 x 30 inches (30.5 x 30.5 x 76.2 cm).

2.4 LOCKER BENCHES.

2.4.01 Tops. 1 1/4 inch (3.2 cm) laminated maple with rounded edges, 9 1/2 inches (24.1 cm) deep, with 3 coat transparent finish, overall height 18 inches (45.7 cm) nominal, length as indicated.

2.4.02 Pedestals. Steel tubing with flanged base zinc-coated and finished in same color as lockers and anchored to top and floor at 6 feet (1.8 m) maximum spacing in accordance with manufacturer's instructions.

2.5 LOCKER GROUPS AND TRIM. Unless otherwise indicated, arrange lockers in single row groups with continuous sloping top hood, and mounted on continuous metal base.

Provide sloping top hoods in addition to locker section flat top and fillers or closures at exposed ends of sloping top hoods formed of minimum 20 gage (1 mm) steel.

Form metal bases of minimum 12 gage (2.7 mm) steel sheet in Z shape, 4 inches (10.2 cm) high with 3 inch (7.6 cm) recess.

2.5.01 Fillers. Provide filler panels at ends of locker groups abutting walls. Form fillers of minimum 18 gage (1.3 mm) steel. Secure fillers to locker body and to building construction with continuous strips.

2.6 MATERIALS AND FABRICATION – GENERAL.

2.6.01 Materials. Fabricate lockers and trim from cold-rolled, oiled, commercial grade steel, free from buckle, scale, and imperfections which impair appearance and strength.

Bolts shall be cadmium plated or subject to other rust-proofing treatment.

2.6.02 Locker Construction. Form tops, backs, bottoms, sides and shelves of minimum 24 gage (.70 mm) steel sheets with flanges as required. Reinforce locker side panels at exposed ends of locker groups. For double-row locker grouping, provide single back common to both rows.

Fabricate door frames of either 1/8 by 7/8 by 1/4 inch (3.2 x 22.2 x 6.4 mm) steel angle uprights or channel uprights, formed of minimum 16 gage (1.6 mm) steel sheets, with formed channel cross members, corners welded, and side of frames forming a continuous door strike.

Provide a keeper projection welded to side of door frames to engage each point of locking device, formed of minimum 14 gage (1.9 mm) steel and designed to prevent freeing of locking device by prying. Provide each keeper with rubber silencers at latching lug, at top and bottom of latching bar or handle insert.

Form shelves with flanges on sides and back and with front edge rolled or flanged with channel formation.

Form doors in one piece of minimum 16 gage (1.6 mm) steel sheet with channel shaped flange on vertical edges and right angle flange on top and bottom edges, unless otherwise specified.

2.6.03 Finish. Metal parts and surfaces, except plated metal, shall be bonderized, factory applied and baked-on finish coat of enamel, which will stand a rigid hammer test without flaking.

2.7 HARDWARE.

2.7.01 Hinges. Minimum 2 inches (5.1 cm) high, full-loop, tight pin style, securely welded to frame and bolted to door. For single tier lockers, provide 3 hinges per door. For double tier lockers and smaller, provide 2 hinges per door.

2.7.02 Locking Devices. Unless otherwise specified, provide positive automatic and prelocking type locking device mechanism which can be locked while the door is open and automatically lock the door when closed with latching bar of channel formation and tamperproof.

Handles for lockers with 2 point or 3 point locking device shall be straight-lift type, of die cast zinc alloy having tensile strength not less than 40,000 psi (275,760 kPa), and with satin chromium-plated finish with latching lift operating in and protected by handle. Provide handles with padlock attachment so arranged that handle or locking device cannot be operated when padlock is in place.

For lockers with one-point locking device, provide built-in, grooved key, 5-pin tumbler spring bolt locker lock such as Master Lock Co. "No. 1714 MK". Provide 2 keys with each lock and 3 master keys.

For lockers with 2 point or 3 point locking device, provide built-in, grooved key, removable only in locked position, 5-pin tumbler dead-bolt locker lock, such as Master Lock Co. "No. 1710 MK". Provide 2 keys with each lock, and 3 master keys.

2.7.03 Coat Hooks. Ball points, free from sharp edges and corners, fabricated of wrought or malleable iron with chromium-plated or other approved finish or of cast aluminum, each bolted in place with 2 bolts.

2.7.04 Number Plates. Provide each locker door with aluminum number plate with black filled numbers not less than 7/16 inch (1.1 cm) high. Securely rivet number plates to door. Arrange numbers in sequence as determined by the Engineer.

PART 3 - EXECUTION

3.1 INSPECTION. Verify prepared bases are in correct position and configuration. Verify bases and embedded anchors are properly sized.

3.2 PREPARATION. Protect adjacent work and materials against damage during progress of the Work.

3.3 INSTALLATION. Install the work in strict accordance with the manufacturer's printed instructions and the approved Shop Drawings.

Anchor metal base to floor with machine bolts and expansion shields or power-driven studs installed through horizontal flange. Close exposed ends flush.
Align lockers horizontally, vertically, and rigidly secure them to the base and wall. Bolt adjacent locker sections together.

Install all end panels and filler panels required. At completion, adjust all doors to operate freely without sticking or binding and to close tightly.

3.3 CLEANING. Following completion, clean finished surfaces and leave work free of imperfections.

End of Section

INDEX

DIVISION 11 – EQUIPMENT

SECTION 11050

EQUIPMENT GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE. This section includes the basic requirements for equipment furnished under Division 11. This section supplements Master Specification Division 01, General Requirements. Additional requirements for pumps are addressed in Master Specification Section 11100, Pump Applications General Requirements. Where provisions of other sections conflict with those in this section, the more stringent of the requirements shall apply.

Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Contract drawings and specifications, and engineering data, instructions, and recommendations of the equipment manufacturer. The work shall be complete and ready for satisfactory operation whether or not each and every item is shown on the Drawings or specifically mentioned in these Specifications.

1.2 GENERAL.

1.2.01 Coordination. Construction and installation shall comply with all required regulatory agencies, including federal, state and local agencies related to the work. All equipment and miscellaneous accessories and appurtenances shall be new. No previously used material of any kind shall be incorporated into any of the building systems.

1.2.02 General Equipment Stipulations. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with applicable technical standards and suitable for maximum working pressure, test pressure and temperatures required.

Packaged equipment, where specified, shall be completely factory-assembled equipment. Packaged equipment shall include all mechanical and electrical components mounted on a common base or in a common enclosure with all piping, controls and wiring factory installed ready to be incorporated into the system.

Motors shall be as specified in Master Specification Section 16220, General Purpose Induction Motors - Procurement, unless indicated otherwise. Electrical equipment provided will be completely wired except for external connections, and will be securely attached to equipment, unless indicated otherwise.

All electrical work, wire and conduit provided shall meet the requirements of Master

Specifications Division 16, Electrical. Control panels, motor starters, and other electrical devices furnished as part of the Equipment shall also comply.

Wire and terminal numbering and wire color requirements shall be as specified in Master Specification Division 16, Electrical. Wiring diagrams are required in the form called for in Master Specification Division 16, Electrical.

Motors and other equipment with moving parts shall be especially selected for quietness of operation. The full load operating noise levels for interior equipment shall not exceed 80 dBA at a distance of 3 feet (91.4 cm) from the surface of the equipment in accordance with ANSI S1.4-1971. The full load operating noise levels for exterior equipment shall not exceed 70 dBA as measured at any point 20 feet (6.1 m) from the surface of the equipment.

Wherever static and dynamic balancing of equipment is specified, vibration velocities measured at equipment shafts or other rotating shaft bearing caps, shall not exceed 0.1 inches (2.5 mm) per second peak in any plane. In case of conflicts between codes or references, the code or reference with more stringent requirements shall be used. To use a lesser code or reference, written permission by the Engineer shall be obtained.

Procure vibration isolation devices for isolating equipment from the building structure from a single vibration materials manufacturer through a local representative. Furnish the local representative with copies of Shop Drawings of all equipment requiring vibration isolation.

For equipment requiring factory installation of vibration isolators, furnish the equipment manufacturer with the identity of the supplier of the vibration isolation manufacturer selected for the Project. Submittals for equipment not equipped with the product of the vibration isolation manufacturer selected for the Project will be rejected.

1.2.03 Governing Standards. All equipment and systems shall comply with Federal, State, and local regulations. Construction and installation shall be in accordance with relevant technical and industrial associations such as NFPA, AWWA, ASTM, ASHRAE, ANSI, etc., insofar as they apply and in accordance with best industry practice. See Master Specification Section 01020, Documentation Standards for a more complete list of abbreviation definitions.

American Society of Mechanical Engineers (ASME) – Boiler and Pressure Vessel Code. Section IX - Welding Qualifications

ASNT SNT-TC-1A (American Society for Nondestructive Testing) - Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

American Society of Testing and Materials (ASTM) A48, Gray Iron Castings

ASTM A276, Stainless and Heat-Resisting Steel Bars and Shapes

ASTM A36, Structural Steel

ASTM A322, Steel Bars, Alloy, Standard Grades

American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) 112-84 - Test Procedures for Polyphase Induction Motors and Generators

Anti-Friction Bearing Manufacturers' Association (AFBMA) Std 11-78 - Load and Fatigue Life for Roller Bearings

AWS D1.1 (American Welding Society) Structural Welding Code – Steel

Hydraulic Institute (HI) USA

National Electrical Manufacturers' Association (NEMA) MGI-78 – Motors and Generators

QC1 - Standard for Qualification and Certification of Welding Inspectors

Underwriters Laboratories (U.L.) 1004-84 - Motors, Electric

1.2.04 Reference To Design Drawing Schedules.

Refer to equipment schedules, where applicable for equipment identification numbers corresponding area locations, capacities, and design requirements.

Wherever schedules or notes appear in the Contract Documents indicating sizes and capacities of equipment, provide equipment under the Contract, which complies. Unless specified elsewhere, the following guidelines shall be followed in selecting equipment. Motor horsepower ratings specified or shown are the minimum acceptable. Indicated motor speeds are the maximum acceptable. The rpm, outlet velocities, tip speeds, and pressure ratings specified are the maximum that will be accepted.

If a motor is provided having a larger horsepower rating than specified, provide the associated increased wire, breaker, starter, fuses, overload protection, etc. Do not provide increased motor horsepower that together adds more than 5 percent to the load of an electrical distribution equipment item (e.g., Motor Control Center, Power Panel, etc.).

1.3 QUALITY ASSURANCE.

1.3.01 Contractors Qualifications. The contractor shall obtain manufacturer's printed equipment installation instructions to aid in properly executing work of installing equipment whenever such instructions are available.

Erect equipment in a neat and workmanlike manner. Align, level, and adjust for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviation from arrangements indicated may be made.

1.3.02 Manufacturer's Field Services. The Contractor shall furnish services of a factory-trained Service Engineer, specifically trained and having experience with installation procedures and operation and maintenance requirements for the type of equipment supplied under these specifications. Manufacturer(s) services shall be in conformance with Master Specification Section 01060, Quality Control. Where specified the Service Engineer shall make not less than two separate 8-hour visits to the Site. On the first visit he shall instruct the Owners and Contractors personnel in the proper means and methods for installation of the equipment, and shall check that equipment and accessories are present and in acceptable condition. On the second visit he shall check that the Contractor has properly installed the equipment, he shall supervise the required performance tests and instruct the Owner's personnel in the proper methods of operating and maintaining the equipment.

The period of Services shall be as specified in the contract and FormSpec. If more time is required because of Contractors activities or problems with equipment, additional time shall be at Contractor's expense.

1.3.03 Testing. Tests shall be performed in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts and Tools. Testing shall include but is not limited to Certified Shop Tests, Factory and Field Acceptance Tests. If specified, testing method, location and facility shall be approved and witnessed by the Engineer.

Vibration Testing of Rotating Equipment: Where specified, the contractor shall provide the services of a qualified vibration consultant to take vibration velocity measurements on all rotating equipment in accordance with HI 1.1-1.5.

Take measurements on the bearing caps of each piece of equipment in the vertical, horizontal, and axial directions or, if bearings are concealed, take the readings at the equipment mounting feet.

Maximum allowable self-excited, total unfiltered vibration velocity shall be 5.5 mils per second peak to peak. If the measured velocity exceeds this figure, determine the source of the vibration and make the necessary corrections to bring the velocity figure to within the specified maximum.

Submit on approved data sheets the vibration measurements for each piece of rotating equipment.

1.4 SUBMITTALS. In accordance with the procedures and requirements set forth in Master Specification Section 01080, Project Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

Shop, assembly and erection drawings.

Equipment specifications and data sheets identifying all materials used and methods of fabrication.

Installation and start-up instructions.

Weights of all component parts, assembled weight of units and approximate total shipping weight.

Example equipment nameplate data sheets.

Interconnecting ladder-type wiring diagrams for power and control wiring required for final connections. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed. Identify all wiring and terminals with a numbering system, which corresponds with the Owner's standards.

Narrative type description of control sequences corresponding to the ladder-type wiring diagrams. These shall be provided even for packaged systems.

List of recommended spare parts.

Products once reviewed shall be rechecked and/or retested by the Contractor, if warranted, at the time of actual installation.

The equipment performance and ratings shall be submitted.

Certified test results shall be submitted to the Contractor.

Tests shall be conducted in accordance with these specifications and industry standards.

Products that are modified, repaired or re-worked shall be tested again.

Submit list of manufacturers and model numbers.

Submit special tools list.

Submit samples.

Submit maintenance and operation manual for each manufactured product.

Each submittal shall also be identified by the applicable Equipment Identification Number and Specification Section as required by Master Specification Section 01080, Project Submittals.

The specific equipment proposed for use by each Contractor on the project may require changes in construction materials, structures, auxiliary equipment, piping, electrical, mechanical, controls, or other Work to provide complete and satisfactory operating installation. The Contractor, with proposed changes, shall submit to the Engineer, for approval, all necessary drawings and details showing such changes to verify conformance with the overall project and overall operating performance. The bid price shall include all cost associated with changes to construction work, drawings or specifications to accommodate the proposed equipment, including increases in the costs of other contracts.

See Master Specification Section 01080, Project Submittals for Schedule of Submittals and additional information pertaining to this section.

1.4.01 Coordination Drawings. Prepare coordination drawings to a minimum scale of 1/4 inch equals 1 foot (6.4 mm equals 30.5 cm) (1:48). Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

Proposed location of equipment, and materials.

Clearances for installing and maintaining insulation.

Clearances for servicing and maintaining valves and equipment, including space for equipment disassembly required for periodic maintenance.

Equipment service connections and support details, including any conduit stub-up locations.

Exterior wall and foundation penetrations.

Fire-rated wall and floor penetrations.

Sizes and location of required concrete pads and bases.

Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

Floor plans, elevations, and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items

1.7 NAMEPLATE DATA. All equipment, piping, valves, ductwork, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate in an accessible location. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/4 inch (19mm) high for section identity and 1/8 inch (3 mm) high for other information Nameplates and tags shall be at least 12 gage (2.66 mm) thickness. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be located in an accessible location with corrosion-resistant mechanical fasteners.

1.8 SUPPORTS AND HANGERS. The Contractor is fully responsible for the structural adequacy of all hangers and supports installed under this contract.

1.9 IDENTIFICATION. Each unit of equipment shall be identified with the equipment item number. A corrosion resistant tag or nameplate, securely affixed in a conspicuous place on each unit shall give the equipment item number, manufacturer's name or trademark and such other information as the manufacturer may consider necessary, or as specified, to complete identification. Equipment tag number shall be assigned by the Engineer.

1.10 DELIVERY, STORAGE AND HANDLING. The transportation, handling and storage of all equipment shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.10.01 Shipping. Equipment, material and spare parts shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.

Spare parts shall be packed in containers bearing labels clearly designating contents and pieces of equipment for which intended. Containers shall be suitable for long term storage and shall protect their contents from moisture and physical damage.

Spare parts shall be delivered at same time as pertaining equipment. The contractor shall coordinate and make arrangements to deliver spare parts to the owner.

1.10.02 Receiving. Equipment, material and spare parts shall be stored and safeguarded in accordance with the Manufacturer's recommendations for protection from weather, temperature, and moisture contamination. The Contractor is liable for any and all damages to the products during his possession.

1.11 WARRANTIES. Refer to Master Specification Section 01170, Warranties and Bonds for provisions concerning Contract general warranty, correction of Work period and for form of special warranty. Submit special warranties for the products so specified elsewhere in Master Specification Division 11.

1.11.01 Service During Contract Correction Period. In the event of the failure of any system or its component equipment items or the improper functioning thereof, the Contractor shall have competent service personnel available, for the restoration and repair of systems and equipment.

Should the nature of the failure be such as to present an emergency, in the opinion of the Engineer and/or Owner, such personnel shall be promptly available, regardless of the hour of the day or the day of the week.

PART 2 - PRODUCTS

2.1 GENERAL. Reference shall be made to individual Master Specification Sections for detailed specifications of products.

2.2 GUARDS. All equipment shall be provided with removable guards around rotating, reciprocating or other moving parts conforming to MIOSHA requirements. Guards shall be constructed of 12 gauge (2.75 mm) sheet steel with expanded metal portions as required for ventilation and visual inspection.

2.3 EQUIPMENT BASES. All rotating equipment shall be provided with concrete bases, baseplate, vibration isolation, leveling grout and concrete adhesive anchors.

All belt driven equipment shall be provided with a sliding base for belt tension adjustment.

All aluminum surfaces in contact with concrete shall be coated with 12 to 20 dry mils (0.3 to 0.5 mm) of NSF approved paint.

The equipment manufacturer shall furnish adequate templates to accurately place anchor bolts.

2.4 PAINTING. Equipment and identification shall be painted except for stainless steel or machined surface in accordance with Master Specification Section 09900, Painting, unless indicated otherwise. Where practicable, the surface shall be prepared, primed and one finish coat shall be applied by the manufacturer at the factory, with balance of painting applied in the field.

All exterior cast iron and or steel surfaces shall be given two shop coats of Amerlock 400 or approved equal. The color of the finish coat shall be selected by the Engineer.

All cast iron and steel surfaces which will be exposed to water shall be given two coats of Amerlock 400, NSF List 61 approved coating to a thickness of 12 to 16 dry mills, or approved equal. The coating shall be applied in strict conformity with the manufacturer's application directions and shall have no deleterious effect upon the quality, color, taste, or odor of potable water.

2.5 BEARINGS. All bearings, including those provided in gear boxes, drivers, and reducers, except those furnished as an integral part of electric motors, shall conform to these requirements, unless indicated otherwise.

All bearings shall be low friction, heavy duty type constructed completely of stainless steel material specially selected for the service required. The bearings shall have a AFBMA B-10 service life, without adjustment factors, of 100,000 hours.

All bearings shall be equipped with double seals and cap to completely prevent the intrusion of dirt, dust, water, sludge, chemicals, etc., from entering the bearing. The seals shall be effective in preventing the entrance of water from a high pressure hose.

Bearing lubrication requirements shall be scheduled by type of lubricant and time period required for preventative maintenance. Oil shall be ISO-68AW.

All bearing calculations shall assume the most severe duty of the unit while operating continuously for 24 hours a day, 7 days per week.

Use Babbott Grade #2 sleeve bearings for larger motors and pumps.

PART 3 - EXECUTION

3.1 ERECTION, INSTALLATION AND APPLICATION. Apparatus and equipment, furnished and installed shall be of such dimensions and design as to be adapted to the arrangement of the installation and to fit within the limits of the space available. Insulated equipment shall be provided with stand-off brackets for attaching components to allow full insulation thickness.

Tools required to operate, adjust, or make minor repairs to the equipment shall be provided and installed in a wall mounted wood or metal case. The case shall be provided with a lock and two keys.

3.1.01 Building Openings for Admission of Equipment. The contractor shall ascertain from his examination of the Drawings whether any special temporary openings in the building will be required for the admission of apparatus to be furnished and shall provide such openings.

3.1.02 Standard Products. The products and equipment to be furnished shall be essentially the standard product of the manufacturer. Where two or more units of the same product or type of equipment are required, these units shall be the products of the same manufacturer.

Where the requirements of the Contract Documents exceed that of a manufacturer's standard product in terms of quality, performance or efficiency, the manufacturer shall make special provisions to ensure that the product proposed meets the requirements of the Contract Documents.

3.1.03 Substituted Items. Should a substitute item be offered and accepted and the substitute item requires services or utilities other than required by the item substituted for, provide those services or utilities at no additional cost to the Owner.

3.1.04 Coordination. The Contract Documents are not intended to serve as coordinated construction drawings showing all minor adjustments in locations that are required for a fully coordinated installation that respects the work of all trades.

Fully coordinate the work within itself and with the work of other trades to ensure the avoidance of all interferences.

3.1.05 Setting and Alignment of Equipment. Furnish anchor bolts together with templates or setting diagrams.

Equipment and motor pulleys shall be aligned and belt tension adjusted in accordance with manufacturer’s instructions.

Before piping or electrical connections are made, all equipment shall be leveled and aligned on bases and foundations per manufacturer’s instructions and recommended tolerances, using an indicating micrometer. Recheck before start-up. Assure that thrust is balanced, that shaft can be freely rotated by hand and that motor is quiet in operation. After all adjustments are completed, recheck alignment and adjust as necessary. Piping should not place stress on the equipment flanges. Support piping as necessary to meet this requirement, bolt tightly and grout. Final checking and adjustment shall be performed by the manufacturer’s representative, a qualified millwright, or machinist. Proof of such qualification shall be provided to the Engineer.

3.1.06 Lines and Grades. Construct Work in conformity with lines and grades as required.

Lay out the Work and be responsible for lines, elevations and measurements required for the installation of the Work.

Axis lines within building shall be so spaced on each floor level that work may be laid out with metal tape measure having length of 100 feet (30.5 m) maximum. The use of cloth tape for layout will not be permitted.

Benchmarks outside building shall be used from which lines and grades required for installation of work may be set.

3.1.07 Identification. Each component of equipment shall have the manufacturer's name, catalog number and date of manufacture on a plate securely attached to the item of equipment, or the name and catalog number and date of manufacture may be stamped or cast into the body of the item. Nameplates shall also give data pertinent to the operation and characteristics of the equipment.

Tags: Provide brass identification tags attached by tag chain on motorized dampers and on valves (except isolation and by-pass valves installed adjacent to the equipment they serve).

Tags shall be numbered by systems according to a definite code.

Cross-reference between valve tag numbers and diagrams and charts specified above shall give exact function and location of each valve.

3.1.08 Protection of Equipment. After installation, all equipment shall be adequately protected from further construction activities. Electrical equipment controls and insulation shall be protected from moisture, water, or dust damage. All space heaters provided in equipment shall be connected as soon as possible and shall be operated at all times until equipment is placed into operation.

Coated surfaces shall be protected from impact, abrasion, discoloration, and other damage. All coated surfaces damaged shall be recoated.

3.1.09 Access Panels and Doors. Access panels or doors are required through building construction assemblies such as walls, ceilings, partitions and floors to service and maintain control motors, regulators, pressure gauges, thermometers, expansion joints, trap primers, coils, pumps, fans, filters, flexible duct, and other items or devices.

See Master Specification Section 05630, Access Hatches and Master Specification Division 8, Doors and Windows for additional information. Where the building construction assemblies are fire resistant assemblies, the access panels or doors are so specified.

Coordinate the exact location with the work of other trades in order to provide a neat appearance. Install access doors true and plumb with building construction.

The size of access panels and doors shall be of the size required to allow easy human entry through the ceiling or building assembly. In general, the minimum size shall be 24 inches x 18 inches (60.1 cm x 45.7 cm) with minor dimensional changes allowed to fit ceiling or structure requirements.

Verify the exact quantity, size and location of the required access panels and doors after the systems and equipment requiring access have been installed and prior to the closure of the affected ceilings and building assemblies.

3.1.10 Painting. Paint equipment according to DWSD color code in Master Specification Section 09900, Painting. Color of equipment not listed will be as selected by the Engineer or as noted in the specifications.

3.2 GUARDS FOR DRIVES AND ROTATING PARTS.

3.2.01 Belt Guards. Provide guards for belted motor drives unless furnished as an integral part of the equipment.

Rigidly brace guards every 3 feet (0.9 m) height to some fixed rigid part of the equipment or building structure and have at least four upright frame members each of which shall be extended to the floor or base and securely fastened.

Design guards to enclose the drive assembly on all sides and have a minimum clearance of two inches from moving parts, to be removable, and allow for one size increase in motor sheave without reconstruction.

Provide tachometer openings at shafts and an opening for checking belt tension, each with bolted covers.

3.2.02 Direct Drive Guards. Install a solid guard of No. 20 gage (1.00 mm) galvanized steel over the coupling of each item of direct driven equipment.

3.2.03 Fan Inlet and Outlet Guards. Provide screen guards with rigid angle frames on fan inlet and outlet openings that are accessible to personnel.
Extend all guards over exposed rotating shafts.

3.3 FIELD QUALITY CONTROL.

3.3.01 Lubrication. Rotating equipment shall be lubricated in accordance with the manufacturer's directions before it is operated. Rotating equipment shall be re-lubricated as required during construction and upon turning over to Owner.

The housing of bearings requiring grease lubrication shall be equipped with 5/8 inch (16 mm) stainless steel button type head fittings.

Mount grease and oil fittings directly on bearings. Where grease lubrication points are not accessible during operation, the grease lubrication points will be brought to a single convenient lubrication panel (one per side of machine, if required) using stainless steel tubing.

3.3.02 Tests. Equipment Field Tests & System Tests shall be conducted by the Contractor in the presence of the Engineer. Contractor shall furnish gauges, instruments, test equipment, and personnel required for testing. Adjust equipment to perform with the least possible noise and vibration consistent with its duty. Noise level of equipment shall be below the standards allowed by OSHA regulation 29 CFR-1910.95 for eight hours of continuous exposure. Allowable vibration amplitude shall be 2.0 mils (0.05 mm) maximum for blowers or any 3600 rpm machinery, and

4.0 mils (0.10 mm) for other machinery or as defined in appropriate standards. Test gauges shall be certified within last 6 months.

All pumps 4 inches (10.2 cm) and above shall be field tested.

Operate all piping systems, make all adjustments in controls and equipment, and complete necessary balancing to deliver fluid quantities specified for each equipment item. Operate all pumping equipment during the system test. Measure and record suction and discharge pressure of each pump operating alone, at the following five points on the pump curve, at maximum rpm, 125%, 100%, 70%, 30% and 0% of maximum flow.

Measure and record volumetrically, the flow rate of each pump operating alone at eight points on the pump curve to include shut-off. Measure and record shut-off head pressure of each pump. Verify pump performance by comparison with Hydraulic Institute Standards and horsepower or operating current for each test condition outlined above. Repair or replace pumping equipment if tests show pumping equipment does not perform within 3 percent of certified manufacturer's curves for flow and horsepower.

The Contractor will supply a certificate of installation stating that the equipment is properly installed and adjusted to operate as designed. This certificate will be required before the equipment can be placed into service. The Engineer will define what equipment requires installation certification.

3.3.02 Welder Qualifications and Procedures. Before any welding is performed, submit a copy of the standard welding procedure specification together with the procedure qualification record as required by Section IX of the ASME Boiler and Pressure Vessel Code.

Before any welder shall perform any welding, submit a copy of the Contractor's record of welder or welding operator qualification tests as required by Section IX of the ASME Boiler and Pressure Vessel Code. Welders who have been inactive with the welding process for a period of more than three months, or six months if allowed by the particular code for which their qualifications are being reviewed, shall be requalified.

The types and extent of non-destructive examinations required for pipe welds are as shown in table 136.4 of ANSI B31.1. If requirements for non-destructive examinations are to be other than that stated above, the degree of examination and basis of rejection shall be a matter of prior written agreement between the fabricator, or Contractor and the purchaser. Qualifications for non-destructive testing personnel shall be as established by the American Society for Nondestructive Testing in their recommended practice No. SNT-TC-1A.

Welding inspectors shall meet requirements of AWS QC-1.

The manufacturer or Contractor shall be responsible for the quality of welding done by his organization and shall repair or replace any work not in accordance with these Specifications.

ASME Section VIII

Division 1 Pressure Vessel & Addenda

Division 2 Pressure Vessels Alternative Rule

Welding done to fabricate structures other than piping and vessels shall conform to the requirements of AWS D1.1.

3.4 SPARE PARTS, SPECIAL TOOLS AND MANUALS.

3.4.01 Operation and Maintenance Manuals. Submit operation and maintenance manuals for each system, except as otherwise specified herein, and for each piece of equipment. This section supplements Master Specification Section 01160, Training and Operation and Maintenance Manuals.

Furnish copies of the manual bound in hardback binders or an approved equivalent. One complete manual shall be furnished prior to system or equipment performance testing and the remaining manuals shall be furnished before the Contract is completed.

The following identification shall be inscribed on the cover: the words "Operating and Maintenance Manual", the name and location of the building, the project name, and the name of the Contractor.

The manual shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of the local representatives for each item of equipment and each system. The manual shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject. The instruction sheets shall be legible and easy to read, with large sheets of drawings folded in.

The manual shall include, but not be limited to, the following:

Installation instructions.

Detailed starting, operating, and shut down procedures.

A control sequence describing start-up, operation and shutdown.

Maintenance and overhaul instructions.

Safety precautions, diagrams, and illustrations.

Test procedures.

A detailed description of the function of each principal component of the system.

Performance data.

Wiring and control diagrams with data to explain detailed operation and control of each component.

Lubrication schedule including type, grade, temperature range, and frequency.

List of size, location and number of filters.

List of size and location of V-belts.

Parts lists with sources of supply, recommended spare parts, and local qualified service organization to service and maintain equipment systems.

The manual shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances provided.

3.4.02 <u>Operating Instructions</u>. As part of O & M Manuals, Contractor shall furnish laminated operating instructions for each system and each principal piece of equipment that can be posted adjacent to each principal piece of equipment for the use of operation and maintenance personnel. Where special tools are the too large to fit in a metal box, consult with the Owner for the appropriate turnover requirements. Where special tools are too large to fit in a metal box, consult with the Owner for the appropriate turnover requirements.

The operating instructions shall include start-up, proper adjustment, operating, lubrication, safety precautions, emergency shutdown procedures in the event of equipment failure, and any other necessary items of instruction as recommended by the manufacturer of the unit.

The operating instructions shall include wiring and control diagrams showing the complete layout of the entire system including equipment, piping, valves, and control sequence and shall be framed under glass or in approved laminated plastic and posted where directed.

Operating instructions shall be laminated with durable materials to prevent damage from moisture, sunlight, extreme temperatures, and delimitation.

3.4.02 Special Tools. The contractor shall furnish, in a suitable metal box, a complete set of all special tools necessary to disassemble, service, repair, operate, and adjust each piece of equipment. All wrenches and spanners shall be case hardened steel and shall have a bright finish with working faces dressed to fit nuts and bolt heads. Where special tools are too large to fit into a metal box, consult with the Owner for direction.

Special tools shall include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, or maintenance. All special tools required to assemble, disassemble, repair, or maintain any item of equipment shall be furnished with the equipment. A separate set of special tools shall be furnished with each separate item of equipment.

Furnish all special tools necessary to disassemble, service, repair and adjust the equipment.

3.4.03 Spare Parts. The Contractor shall furnish a complete inventory of spare parts for equipment as stated in these specifications.

Shop drawings submitted for all items of equipment shall include complete current published parts information, which shall clearly identify the manufacturer's recommended spare parts. Spare parts lists, included with the submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished.

Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number.

All spare parts shall be properly packed in storage containers suitable for long term storage providing protection from moisture and mechanical drainage. All spare parts, supplies, and special tools shall be supplied as directed by the Engineer. Deliver all spare parts, supplies and special tools to project site as directed by the Engineer.

End of Section

SECTION 11100

PUMP APPLICATIONS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE. This section includes the general requirements for pump applications, including pump motors, electrical characteristics, assembly, testing and other items that are common to most pumps and accessories furnished under Master Specification Division 11, Equipment. This section supplements Master Specification Section 11050, Equipment General Provisions. Items special to different types of pumps will be addressed in each individual pump specification. Where provisions of other sections conflict with those in this section, the more stringent of the requirements shall apply.

1.2 GENERAL.

1.2.02 Governing Standards.

H.I.S. – Hydraulic Institute Standards

ANSI – American National Standards Institute

OSHA – Occupational Safety and Health Administration

ASTM – American Society for Testing and Materials

NEMA – National Electrical Manufacturing Association

1.2.02 Electrical Requirements. Electrical equipment provided will be completely wired except for external connections, and will be securely attached to equipment, unless indicated otherwise. Electrical equipment, wiring, conduit, wire terminal numbering, wiring diagrams, wire color, control panels, motor starters, and other electrical devices furnished shall meet the requirements of Master Specification Division 16, Electrical.

1.2.03 Motors and Other Equipment. Motors and other equipment with moving parts shall be especially selected for quietness of operation. The full load operating noise levels for interior equipment shall not exceed 80 dB at a distance of 3 feet (91.4 cm) from the surface of the equipment, in accordance with ANSI S1.4. The full load operating noise levels for exterior equipment shall not exceed 70 dB as measured at any point 20 feet (6.1 m) from the surface of the equipment. Motors shall be as specified in Master Specification Division 16, Section 16220, General Purpose Induction Motors, unless indicated otherwise.

1.2.04 Balancing and Vibrations. Wherever static and dynamic balancing of equipment is specified, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4 W/N (oz*in).

Vibration isolation devices for isolating equipment from the building structure shall be provided. Procure these devices from a single vibration materials manufacturer through a local representative. Furnish the local representative with copies of Shop Drawings of all equipment requiring vibration isolation.

For equipment requiring factory installation of vibration isolators, furnish the equipment manufacturer with the identity of the supplier of the vibration isolation manufacturer selected for the Project. Submittals for equipment not equipped with the product of the vibration isolation manufacturer selected for the Project will be rejected.

In case of conflicts between codes or references, the code or reference with more stringent requirements shall be used. To use a lesser code or reference, written permission by the Engineer shall be obtained.

1.3 QUALITY ASSURANCE. Pumps are to be engineered and manufactured under a written Quality Assurance program. The Quality Assurance program is to be in effect for at least 5 years, to include a written record of periodic internal and external audits to confirm compliance with such program.

1.3.01 Manufacturer's Qualifications. The pump manufacturer shall have a minimum of 5 years experience with the successful manufacture and installation of the type of pumps specified and shall provide references on a minimum of 10 pumps of that type that have been in service a minimum of 5 years. Pump manufacturer shall be prepared to supply references upon request. Pump manufacturer shall have a history of maintaining an extensive parts inventory for its pumps.

1.3.02 Manufacturer's Field Services. The Contractor shall furnish services of a factory-trained Service Engineer, specifically trained on installation procedures and operation and maintenance requirements for the type of pump supplied under this specification. The Service Engineer shall make not less than two separate 8-hour visits to the Site. On the first visit he shall instruct the Owners and Contractors personnel in the proper means and methods for installation of the pumps, and shall check that all pumps and accessories are present and in acceptable condition. On the second visit he shall check that the Contractor has properly installed the pumps, he shall supervise the required performance tests and instruct the Owner's personnel in the proper methods of operating and maintaining the Pumps.

If more time is required because of the Contractor's activities or problems with equipment, the additional time shall be provided at the Contractor's expense.

1.3.03 Testing. All tests shall be performed in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools and industry standards. Testing shall include but is not limited to Certified Shop Tests, Factory Acceptance Tests, and Field Acceptance Tests. The Standards of the Hydraulic Institute shall govern the procedures and calculations for these tests. The limits of vibration as set forth in the Standards of the Hydraulic Institute shall govern. All testing shall be witnessed by the Engineer.

Large pumps (as determined by the Engineer) shall be individually factory tested in accordance with Hydraulic Institute Standards and a Certified Test Curve shall be provided as requested by the Engineer.

At no cost to the Owner, the manufacturer shall have each pump tested for the operating ranges defined on the pump schedule. Each test shall be conducted a minimum of 3 times to obtain representative results. Products that are modified, repaired or re-worked shall be tested again.

The Contractor shall, before contracting with the Manufacturer for the pumps, submit the guaranteed performance curve showing the efficiency of the pump at the design conditions specified and its performance over the full range of operation.

Field Acceptance Testing shall be performed in the presence of the Owner, facility superintendent, and the design engineer at the cost of the pump manufacturer.

Vibration Testing: The contractor shall provide for the services of a qualified vibration consultant to take vibration velocity measurements on all large, special order rotating equipment in accordance with ANSI HI 1.1-1.5. He shall take measurements on the bearing caps of each piece of equipment in the vertical, horizontal, and axial directions or, if bearings are concealed, take the readings at the equipment mounting feet.

Maximum allowable self-excited, total unfiltered vibration velocity shall be 5.5 mils per second peak to peak. If the measured velocity exceeds this figure, determine the source of the vibration and make the necessary corrections to bring the velocity figure to within the specified maximum.

Submit on approved data sheets the vibration measurements for each piece of rotating equipment.

1.4 SUBMITTALS. Before the pumps are assembled by the Manufacturer, the Contractor shall submit shop drawings to the Engineer for approval.

1.4.01 Drawings and Data. Submit the following product data:

Submit list of manufacturers, types, and model numbers.

Equipment specifications and data sheets identifying all materials used and methods of fabrication.

For pumps, include rotative speed, type of bearings and method of lubrication, suction and discharge nozzle sizes, net weight of pump only, and performance curves showing capacity versus head, pump efficiency, and horsepower.

For motors, include type of bearings and method of lubrication, rated size of motor in horsepower, temperature rating, full load rotative speed, net weight, service factor, locked rotor and full load current, and starting, full load, and breakdown torque.

Installation and start-up instructions.

Weights of all component parts, assembled weight of units and approximate total shipping weight.

Nameplate Data

Example equipment nameplate data sheet.

Interconnecting ladder-type wiring diagrams for power and control wiring required for final connections. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

Verbal description of control sequences corresponding to the ladder-type wiring diagrams. These shall be provided even for packaged systems.

Equipment performance and ratings.

Recommended spare parts list.

Special tools list.

Operation and maintenance manuals for each manufactured product.

Manufacturer's installation and start up instructions.

Data on shop painting.

Job site storage requirements

Submit complete fabrication, assembly, foundation, and installation shop drawings to a minimum scale of 1/4 inch (6.4 mm) equals 1 foot (30.5 cm). Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to efficient flow of the Work. Include the following:

Proposed location of equipment, and materials.

Exterior wall and foundation penetrations.

Equipment service connections and support details.

Clearances for installing and maintaining insulation.

Clearances for servicing and maintaining valves and equipment, including space for equipment disassembly required for periodic maintenance.

Fire-rated wall and floor penetrations.

Sizes and location of required concrete pads and bases.

Scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

Floor plans, elevations, and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

Motor Certified Dimension Print and Frame Size

1.5 <u>DELIVERY, STORAGE, AND HANDLING</u>.

1.5.01 <u>Shipping</u>. Equipment, material and spare parts shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.

Spare parts shall be packed in containers bearing labels clearly designating contents and pieces of equipment for which intended. Containers shall be suitable for long term storage and shall protect their contents from moisture and physical damage.

Spare parts shall be delivered at same time as pertaining equipment. The contractor shall coordinate and make arrangements to deliver spare parts to the owner.

1.5.02 <u>Receiving</u>. Equipment, material and spare parts shall be stored and safeguarded in accordance with the Manufacturer's recommendations for protection from weather, temperature, and moisture contamination.

1.6 <u>WARRANTY</u>. The pump manufacturer shall warrant the units being supplied to the Owner against defects in workmanship and material for a period of 1 1/2 years, unless otherwise specified, from the date of acceptance by Owner. If Manufacturer cannot provide a warranty of this duration, then the Contractor shall provide the warranty coverage specified.

PART 2 - PRODUCTS

2.1 <u>GENERAL</u>. Pump specific information will be provided in each specific pump specification as well as on the drawings and diagrams.

2.2 <u>NAMEPLATE DATA</u>. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, date of manufacture, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Locate nameplates in an accessible location.

2.3 <u>BEARINGS</u>. All bearings, including those provided in gear boxes, drivers, and reducers, except those furnished as an integral part of electric motors, shall conform to these requirements, unless indicated otherwise.

All bearings shall be anti-friction type constructed completely of stainless steel material specially selected for the service required. The bearings shall have a B-10 life, without adjustment factors, of 100,000 hours.

All bearings shall be equipped with double seals and cap to completely prevent the intrusion of dirt, dust, water, sludge, chemicals, etc., from entering the bearing. The seals shall be effective in preventing the entrance of water from a high pressure hose.

Bearing lubrication requirements shall be scheduled by type of lubricant and time period required for preventative maintenance.

Calculations of bearing life shall be submitted with the shop drawings for approval by the Engineer.

All bearing calculations shall assume the most severe duty of the unit while operating continuously for 24 hours a day, 7 days per week.

2.4 PUMP CONNECTIONS. All pumps shall be flanged, unless otherwise specified, and the flanges shall be drilled to suit 125 lbs. ANSI piping system. The pumps shall conform to all applicable AVS or ANSI standards.

Use Babbott Grade #2 sleeve bearings for larger motors and pumps.

2.5 NOISE LEVEL. Sound pressure levels shall be measured according to IEEE 85 and shall not exceed 80 decibels as measured on the A-Weighted Scale at a distance of five (5) feet from any motor surface under no load, free field conditions.

PART 3 - EXECUTION

3.1 INSTALLATION. Install pumps, motors, and accessories in accordance with the manufacturer's printed installation instructions.

Erect equipment in a neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviation from arrangements indicated may be made.

Apparatus and equipment, furnished and installed shall be of such dimensions and design as to be adapted to the arrangement of the installation and to fit within the limits of the space available.

Insulated equipment shall be provided with stand-off brackets for attaching components to allow full insulation thickness.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. Upon completion of the installation, the Contractor shall be required to make performance tests of all pumps in the field, under the direction of the Engineer. Startup and Testing shall be performed in accordance with Master Specification Section 11050, Equipment General Provisions. The Pump Manufacturer will be entitled to have representatives present during these field tests. During the tests, the operation of the unit may be under the direction of the Pump Manufacturer's representative if he so desires. The Contractor shall provide competent personnel to make any necessary alterations to achieve proper operation of the pumping equipment without voiding the manufacturer's warranty.

Measure and record volumetrically, the flow rate of each pump operating alone at eight points on the pump curve to include shut off. Measure and record shut-off head pressure of each pump. Verify pump performance by comparison with Hydraulic Institute Standards and horsepower or operating current for each test condition outlined above. Repair or replace pumping equipment if tests show pumping equipment does not perform within three percent of certified manufacturer’s curves for flow and horsepower.

3.3 SPARE PARTS & SPECIAL TOOLS.

3.3.01 Special Tools. The contractor shall furnish, in a suitable metal box, a complete set of all special tools necessary to disassemble, service, repair, operate, and adjust each pump. All wrenches and spanners shall be case hardened steel forgings and shall have a bright finish with working faces dressed to fit nuts and bolt heads. Where special tools are too large to fit in a metal box, consult with the Owner for the appropriate turnover requirements.

3.3.02 Spare Parts. The contractor shall furnish spare parts as defined in each specific pump specification as well as all others recommended by the supplier and those identified during the submittal process.

Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. All spare parts shall be properly packed in storage containers suitable for long term storage providing protection from moisture and mechanical drainage. All spare parts, supplies, and special tools shall be supplied to project site as directed by the Engineer.

End of Section

Table 1 - Specific Pump Applications

Spec No	Pump Type	Primary or Best Applications	Head Ranges/Flow Ranges	Preferred Manufacturers	Testing & Manufacturer Support	Spare Parts (Quantities for 1 - 4 pumps, Double for 5 - 10 pumps)
11200	Vertical Turbine Pump	Medium sized pump used to pump clean water or storm water (low lift single stage) typically at pump and lift stations.	Variable/Variable	Fairbanks-Morse Johnston Pump ITT-AC	Often a shelf item. Need factory certified curve. Witness required for factory testing unless otherwise identified by Owner. Manufacturer's representative to inspect installation and provide training to owner's maintenance staff along with training videos. Need witness testing.	1 Impeller 1 Set of Pump Bearings 1 Intermediate Shaft Bearings 1 Set of Motor Bearings 1 Set of Shaft Couplings 1 Set of Casing Wear Rings 1 Set of Impeller Wear Rings
11210	Submersible Pump	Used to pump clean water, sewage, and storm water, these pumps do not require a drywell thereby reducing initial costs. Typical applications are lift and pumps stations.	< 100 ft/<1000 gpm	ITT Flygt Corp., EMU-Davis, KSB, Inc.	Often a shelf item. Need factory certified curve. Witness required for factory testing unless otherwise identified by Owner. Manufacturer's representative to inspect installation and provide training to owner's maintenance staff along with training videos. Need witness testing.	1 Impeller 1 Set of Bearings 1 Set of Casing Wear Rings 1 Set of Mechanical Seals 1 Set of seals, O-rings & gaskets Need complete list of special tools
11220	Axial Horizontal Split Pump	An extremely efficient pump normally used to move high volumes of clean water at larger pump stations	N/A/<75 mgd	Ebara, Japan ITT-A C Patterson	Sizes 48" and up are not a shelf item. Manufacturer should provide individual pump curve for each pump. Engineer must witness factory testing.	1 Impeller, 1 Impeller Hub or Shaft Sleeve, 1 Set of Pump Bearings 1 Set of Wear Rings 1 Set of O-Rings & Gaskets 1 Set of Couplings (Koppers)
11300	Dry Pit Solids Handling Pump	The recognized work horse in DWSD for moving large quantities of sewage	< 100 ft/500-20K gpm	ITT-AC Fairbanks Morse Morris	Typically a shelf item. Need factory certified curve. No witness required for factory testing. Manufacturer's representative to inspect installation and provide training to owner's maintenance staff along with training videos. Need witness testing.	1 Pump Shaft Sleeve 1 Sets of Pump Bearings 1 Intermediate Shaft Bearings 1 Set of Shaft Couplings (Koppers) 1 Set Casing & Impeller Wear Rings 1 Limited End Float
11310	Self Priming Pump	Sewage	< 100 ft/< 2000 gpm	Gorman-Rupp ITT-AC	Often a shelf item. Need factory certified curve. Witness required for factory testing unless otherwise identified by Owner. Manufacturer's representative to inspect installation and provide training to owner's maintenance staff along with training videos. Need witness testing.	1 Impeller 1 Set of Bearings 1 Wearplate 1 Set of Mechanical Seals

Table 2 - General Pump Utilization

	Pump Type	01080-Project Submittals	01160-Training & Operation & Maintenance Manuals	11050-Equipment General Provisions	11100-Pump Application General Requirements	11200-Vertical Turbine Pumps	11210-Submersible Pumps	11220-Axial Horizontal Split Case Pumps	11300-Dry Pit Solids Handling Pumps	11310-Self-Priming Pumps	11320- Recessed Impeller Pumps	11330-Plunger Pumps	11340-Dry Pit Horizontal Chopper Pumps	11650-Sump Pumps	11700-Sampling Pumps	11730-Mixers	11740-Chemical Feed and Transfer Pumps	11745-Chemical Feed Equipment	11975-Blower	16220-Motors
CLEAN WATER	BACKWASH	*	*	*	*	*		*												*
	HI-LIFT	*	*	*	*	*		*												*
	LO-LIFT	*	*	*	*	*		*												*
	PRESSURE BOOSTER	*	*	*	*	*		*												*
	RAW WATER	*	*	*	*	*														*
	SLUDGE	*	*	*	*		*		*											*
	SAMPLE	*	*	*	*		*			*					*					*
STORMWATER	INFLUENT	*	*	*	*	*	*		*											*
	DECANT	*	*	*	*	*			*											*
	BASIN DEWATERING	*	*	*	*	*	*		*											*
	SLUDGE	*	*	*	*						*									*
	SAMPLE	*	*	*	*		*			*					*					*
WASTEWATER	Influent Sewage	*	*	*	*		*		*											*
	Intermediate Lift	*	*	*	*	*	*		*											*
	Effluent	*	*	*	*	*	*		*											*
	Primary Sludge	*	*	*	*						*									*
	Secondary Sludge	*	*	*	*		*		*	*	*		*							*
	Return Sludge	*	*	*	*				*	*	*	*	*							*
	Grit	*	*	*	*						*									*
	Scum	*	*	*	*								*							*
	Chemical Additions	*	*	*	*												*	*		*
	Sampling	*	*	*	*		*			*					*					*
	Tank Aeration	*	*	*	*														*	*
	Tank Mixing	*	*	*	*											*			*	*
CHEMICAL	Sodium Hypochlorite	*	*	*	*												*	*		*
	Chlorine Solution	*	*	*	*												*	*		*
	Polymer	*	*	*	*												*	*		*
	Ferric Chloride	*	*	*	*												*	*		*
	Alum	*	*	*	*												*	*		*
	Caustic	*	*	*	*												*	*		*
SERVICE	Sump Pumps	*	*	*	*		*							*						*
	Secondary Water	*	*	*	*			*												*
	Sampling	*	*	*	*		*			*					*					*

SECTION 11200

VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.1 SCOPE. Contractor shall furnish all labor, materials, tools, equipment, and supervision required to install vertical, constant speed turbine pumps with vertical hollow-shaft type motors direct-connected to the pumps with bolted motor couplings. Each pumping unit shall be provided with an electric motor. The pumps shall be utilized for pumping clean or storm water containing some quantities of grit and sand.

These specifications must be used together with Master Specification Sections 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Errors due to failure to reference these sections will be borne by Contractor.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Head and flow rate requirements should be defined in either pump schedule or on the drawings.

2.1.01 Pump Design. The pumps shall be of the vertical type with submerged impellers. They shall be either an axial flow or a mixed flow type, and shall have no more than two stages. The maximum head of pump operations must be at least 2 feet (0.6 m) below the low points of the unstable portion of the curve.

The pumps will be used to pump storm or clean water and shall be designed for frequent starting and stopping and shall be capable of starting against maximum head. The pumps shall be capable of pumping storm water that has passed through a screen with no larger than 1 3/4 inch (4.4 cm) clear openings and which carries suspended sand originating from winter road sanding operations.

Within the required pumping range, the minimum efficiency of the pumps, exclusive of the motor, shall be at least 70 percent. The pumps, at maximum total head, shall not load the motors in excess of their rated horsepower under conditions of normal voltage, frequency, temperature, and clean water. Pumps shall be so constructed that explosive gases from the sump cannot enter the motor room through the pumps.

Based upon the specific pump selected, the pumps shall be capable of passing 2 inch (5 cm) solids and will be tested in the field for this feature prior to installation by the insertion of a 2 inch (5 cm) diameter sphere.

2.1.02 Motor Design Requirements. Each pump shall be provided with a vertical, 460 volt, 3 phase, 60 Hertz, squirrel cage induction motor with normal starting torque, low starting current and shall be of the weather protected, Type 1 type.

2.2 ACCEPTABLE MANUFACTURERS. The pumps shall be Fairbanks, Morse, Johnston Pump, ITT-AC mixed flow pump, or equal.

2.3 PUMP CONSTRUCTION. All materials used in the construction of the equipment specified herein shall be new, high grade, of a quality best suited to the requirements of the work, and shall conform to the latest standard specifications of the American Society for Testing and Materials for all cases covered by such specifications. Castings with holes, cracks, or other defects shall not be accepted.

The pump assembly shall be supported from a base plate of such design that the unit can be easily removed through the openings of the floor and the roof. The column pipe and pump bowl shall be made in sections to permit ready assembly, dismantling, and removal of the impeller. The minimum wall thickness of column pipe shall be in no case less than 3/8 inch (1.0 cm). Joints shall be of the flange type with a gasket or other suitable means to make them watertight. Vanes shall not be used in the construction of the discharge elbow.

2.3.01 Bowl Assembly. The pump bowl and suction bell shall be of ductile iron, semi-steel or a combination of these with a minimum strength of 30,000 psi (206,842 kPa). The pump column, discharge elbow, and pipe shall be composed of flanged sections of mild steel pipe with a minimum thickness of 3/8 inch (1.0 cm). All parts shall be sufficiently strong and reinforced as necessary to stand all loads, including vibrations, and shall also be designed for proper rigidity. The complete unit, when assembled and operating, shall be free from undue vibration, cavitation, noise, or leaks.

2.3.02 Mounting. The motor mounting shall be for a direct-connected motor.

2.3.03 Shaft. The line shaft shall be cold-rolled steel and the impeller shaft shall be stainless steel, both of sufficient diameter to transmit the torque and thrust with a safety factor of not less that 8. The shaft dimensions and bearings spacing shall be so proportioned that no injurious deflection or whip will occur, and bearing spacing of more than 5 feet (1.5 m) will not be approved. The thrust shall be carried by a thrust bearing in the motor. The intermediate and bowl bearings shall be of the bronze sleeve type. Provision shall be made for making any necessary vertical adjustment to the shaft after it has been assembled in the pump unit, and without interfering with its alignment. The shaft shall be enclosed in a shaft-enclosing tube of stainless steel tubing attached to the bearings with tight fittings in such a way as to prevent leakage of liquid into the tubing and bearings, and adequate seals shall be provided at the bearings adjacent to the impellers. The column pipe, shaft tube, and shaft shall be fitted with necessary joints and couplings to permit dismantling the unit into sections of not more than 10 feet (3 m) in length. A shaft joint shall be provided between the motor and the shaft enclosing tube. Provision shall be made for vertical adjustment of the pump shaft and impeller, the point of adjustment being easily accessible to someone in the motor room.

All intermediate shaft couplings shall be made of high grade steel.

2.3.04 Impeller. The pumps shall be provided with dynamically balanced SAE 63 abrasion resistant bronze impellers. Impellers shall be locked to the pump in such a manner as to permit ready inspection and removal, and also to prevent any damage should the direction of rotation become reversed.

The impellers shall have a minimum blade thickness at the outer circumference of not less than 2.2 percent of the maximum diameters of the propellers.

2.3.05 Seals and Greasing. Top and bottom seals shall be so constructed as to permit pressure greasing without blowing the seals. All column bearings and the top bowl bearings shall be lubricated by means of a single fitting for forcing grease into the top of the shaft enclosing tub. A bypass port shall be provided in the lower part of the top bowl bearing for use in determining when grease has reached this bearing. The port shall be through one of the guide vanes and shall be furnished with an elbow and riser extending up above motor base plate (but no less that 18 inches (45.7 cm) above the minimum pumping elevation) and plugged or capped with a standard pipe fitting. Slots shall be provided in all intermediate shaft suction manifold bearings to facilitate the passage of grease to the lower bearings. Intermediate bowl bearings, if used, and suction manifold bearings shall be grease-lubricated through one of the guide vanes and shall be provided with separate grease lines. Grease lines shall be stainless steel and shall have a minimum diameter of 3/8 inch (1.0 cm). They shall extend above the floor plate in the motor room, and terminate in an approved fitting. Exposed grease lines shall be supported from the outer pump column and shall be as close thereto as practicable to avoid mechanical injury to the lines.

2.3.06 Data Plates. All data plates shall be of stainless steel suitably attached to the pumps. Data plates shall contain:

Manufacturer's name.

Pump size and type.

Serial number.

Maximum speed.

Impeller diameter.

Capacity.

Head rating.

Other pertinent data identified by manufacturer.

2.3.07 Hardware. All machine bolts, nuts and capscrews shall be minimum 316 stainless steel of the hex head type. Hardware (or parts) requiring special tools or wrenches shall not be used.

2.4 MOTOR CONSTRUCTION. Pumps shall have maximum horsepower and speed ratings noted hereinafter and shall not overload the motor at any point on the operating curve. Motors shall be as specified in Master Specification Section 16220, General Purpose Induction Motors.

2.5 SHOP TESTING. Each pump shall be assembled at the factory to insure fit of adjoining parts. One pump selected at random by a representative of the Engineer shall be tested at the factory for operating efficiency. A minimum of 8 shall be taken to include 1 each at maximum static head, average static head, 115% of maximum static head, and 85% of minimum static head.

The tests shall be such as to satisfy the Engineer that the equipment complies with the specification requirements. The manufacturer shall furnish 6 certified copies of test curves to the Engineer. The Standard of the Hydraulic Institute shall govern the procedures and calculations for these tests. The limits of vibration as set forth in the Standards of the Hydraulics Institute shall govern.

For vertical turbine pumps large enough to be manufactured with sleeve bearings, factory testing of each unit shall be conducted with a representative of the Engineer present.

PART 3 – EXECUTION

3.1 INSTALLATION. Each pumping unit shall be leveled, plumbed, aligned, and bolted into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to fit properly.

3.1.01 Seals and Greasing. In the field and prior to installing the riser tube on the top bowl bearing, the Contractor shall be required to force grease into the shaft enclosing tube through the grease fitting at the top until grease is forced out of the enclosing tube at the top bearing. The riser tube shall be prefilled with grease prior to installation. After the riser tube has been installed, the Contractor shall again force grease into the shaft enclosing tube until grease is forced from the top of the riser tube. All of this work shall be done in the presence of a representative of the Engineer.

Motor room (or dry well) shall be completely sealed from wet well to prevent sewer gases from accessing the motors and electrical equipment.

3.1.02 Surface Preparation and Shop Painting. The following areas of the pump shall be painted with NSF approved epoxy paint.

Inside of the outer pump column

Outside of the shaft enclosing tube

Inside of the discharge pipe

Both sides of the pump bowl

Outside the outer pump column for entire length below the floor plate

The remainder of the pump exterior, the motor, motor base, and base ring surfaces shall be cleaned and primed with one coat of polyamide epoxy primer followed by 2 coats of green polyamide epoxy finish. Manufacturer shall be Tnemec Epoxoline Series 66 or approved equal.

3.1.03 Cleaning. Prior to acceptance of the work of this section, thoroughly clean all installed materials, equipment and related areas.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. Upon completion of the installation, the Contractor shall be required to make performance tests of all pumps in the field, under the direction of the Engineer. Startup and Testing shall be performed in accordance with Master Specification Section 11050, Equipment General Provisions. The Pump Manufacturer will be entitled to have representatives present during these field tests. During the tests, the operation of the unit may be under the direction of the Pump Manufacturer's representative if he so desires. The Contractor shall provide competent personnel to make any necessary alterations in accordance with the operation guarantee.

3.3 SPARE PARTS.

3.3.01 Spare Parts. The contractor shall also furnish the following spare parts as well as any others agreed to during submittal process:

1 Pump Bowl Assembly

1 Set of Pump Bearings

1 Set of Shaft Couplings

1 Intermediate Shaft Bearings

1 Set of Motor Bearings

1 Set of Casing and Impeller Wear Rings

End of Section

SECTION 11210

SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 SCOPE. This section covers submersible heavy-duty centrifugal pumping units up to the 50 horsepower (37.3 kW) range intended for continuous duty in sewerage and storm water environments. Each pumping unit shall be complete with a close-coupled, submersible electric motor; base connection and all other appurtenances specified or otherwise required for proper operation. Furnish explosion proof motors in hazardous locations where indicated on the drawings.

1.2 QUALITY ASSURANCE.

1.2.01 Source Quality Control. Each pump casing shall be hydrostatically tested to 1.5 times maximum shut off pressure. Each assembled pump shall be fully tested on water and have curves plotted to determine the rated capacity of each pump in accordance with the standards of HI USA.

Drilling templates, space requirements and mounting instructions shall be obtained from pump supplier.

Pumps and motors shall be manufactured and furnished by same manufacturer as a package to insure proper coordination and compatibility of equipment. Pumps of same type shall only be obtained from one manufacturer.

These specifications shall be used together with Master Specification Section 11100, Pump Application Requirements and Master Specification Section 11050, Equipment General Provisions. Any costs resulting from errors due to failure to reference these sections will be borne by Contractor.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. In addition to the submittals required under Master Specification Sections 11050, Equipment General Provision and 11100, Pump Application General Requirements, submit the following data and drawings for motors:

Details of Cable Entry

Type and Size of Cable or cables.

Locked rotor torque in lb-ft.

Number of permissible starts under specified conditions per hour.

Enclosure type.

1.3.02 Certifications. A certified performance test, as specified in Master Specification Section 11100, Pump Application Requirements shall be performed on each pump to prove that it conforms in all respects to its submitted performance criteria.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range.

2.3 ACCEPTABLE MANUFACTURERS. Submersible pumps shall be manufactured by ITT Flygt Corp., KSB Inc., EMU-Davis, or equal.

2.4 MATERIALS.

Motor Housing, Oil Chamber Housing, Impeller and Volute	Cast iron, ASTM A48 Class 35B
Impeller Wearing Ring	Type 316 Stainless Steel
Volute Wearing Ring	Type – 17 – 4 pH Stainless Steel or nitrile coated steel.
Shaft	C 1035 Carbon Steel
All Wetted Assembly Fasteners	Type 316 Stainless steel
Mechanical Seals	Tandem System consisting of two totally independent seal assemblies. Lower seal shall have one stationary and one rotating tungsten carbide ring. Upper seal shall have one stationary tungsten carbide ring and one rotating carbon ring.
Discharge Base	Cast iron ASTM A48 Class 35B

2.4.01 Anchor Bolts. All anchor bolts, nuts, and washers shall be 300 Series stainless steel.

2.5 PUMP CONSTRUCTION. Pumping units shall be mounted on a pedestal base extending from the volute casing to below the bottom of the suction elbow inlet flange. All seams and contact surfaces between steel shapes and plates of fabricated steel pedestals shall be continuously welded and ground smooth. Each pedestal shall be suitable for grouting and bolting to lifting platform.

All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is required. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and water tightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

2.5.01 Volute. Pump volute shall be single-piece grey cast iron, ASTM A48 Class 35B. It shall be of non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. The volute casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. The discharge nozzle shall be flanged, with dimensions and drilling conforming to ANSI B16.1, Class 125. Minimum inlet and discharge size shall be as specified and/or as shown on the Drawings. Pump volutes shall be provided with renewable wear rings.

2.5.02 Pump Seals. Each pump shall be provided with a tandem mechanical shaft sealing system consisting of two independent seal assemblies. The seals shall operate in an oil chamber that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower seal unit between the pump and the oil chamber shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit between the oil chamber and the motor housing shall contain one stationary tungsten carbide ring and one positively driven rotating ceramic ring. Each seal interface shall be held in contact by its independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement. Oil shall be an NSF 61 approved lubricant.

Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods while pumping under load.

2.5.03 Pump Shaft. Pump and motor shaft shall be the same unit. The pump shaft shall be an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be as specified above and shall be completely isolated from the pumped liquid.

2.5.04 Impeller. The impeller shall be a double shrouded non-clogging design one-piece casting. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and retained with an expansion ring. It shall be capable of handling solids, fibrous materials, grit and other matter found in wastewater.

2.5.05 Bearings. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single row roller bearing. The lower bearing shall be a double row angular contact bearing to resist axial thrust and radial forces.

2.6 DRIVE UNITS.

2.6.01 Electric Motors. Each submersible pump shall be driven by a completely sealed and jacketed, heavy duty, electric submersible, squirrel cage induction motor of specified horsepower, minimum 1.15 service factor, specified RPM, 460 volts, 3 phase, 60 Hertz power, housed in an air filled, watertight chamber, NEMA B type. Motor shall be compatible with variable frequency drives for variable speed pumps.. The stator windings and stator leads shall be insulated with moisture resistant Class F insulation rated for 155 °C. The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The rotor bars and short circuit bars shall be made of cast aluminum.

2.6.02 Cooling system and motor protection. Each dry-pit submersible pump shall be provided with a cooling system for continuous pump operation in liquid temperature of up to 104 degrees F (40 degrees C). The cooling systems for the pumps shall consist of a water jacket encircling the stator housing. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. Provisions for external cooling in lieu of a water jacket will not be permitted. The motor insulation and cooling systems shall be designed for at least 10 starts per hour under load.

The motor protection systems shall consist of thermal and leakage sensors. The stators in each motor shall be equipped with two thermal switches per each of the 3 phases or a total of 6 to monitor stator temperature and protect from overheating. The thermal switches per each of the 3 phases or a total of 6 shall be embedded in the stator lead coils to monitor the temperature of each phase winding, and shall be used in conjunction with external motor overload protection and wired to the control panel. Should high temperature occur, the thermal switches shall open, shut down the pump, and activate an alarm.

A leakage sensor shall be provided to detect water in the stator chamber. The monitoring system shall consist of a float switch which when activated, shall activate an alarm.

The thermal sensors and float switch shall be connected to a control and status (CAS) monitoring system provided by the manufacturer. The unit shall be designed to be mounted in any control panel.

The flexible power cables for the pumps shall include an equipment grounding conductor to the pump frames. The cable entry water seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall be comprised of a single cylindrical elastomer grommet, flanked by washers, having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead terminal board, which shall isolate the motor interior from foreign material or moisture gaining access through the pump top.

Each pump shall be equipped with one or more multi-conductor cable assemblies for power and control. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. The power cable shall be sized according to the current NEC and ICEA standards and also meet with P-MSHA approval. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet. All cables shall be of sufficient length to terminate in a junction box as indicated on the drawings, with 10 feet (3 m) of slack. Each cable shall be provided with, and supported by an AISI Series 300 corrosion-resistant stainless steel Kellems or woven grips to prevent damage to the cable insulation.

The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead terminal board. The cable entry junction box shall isolate the motor interior from foreign material or moisture gaining access through the top of the stator housing.

The power cable shall be sized according to the current NEC and ICEA standards and also meet with P-MSHA approval. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet

2.7 PULL UP DESIGN. The submersible pump shall be of the pull up design with stainless steel guide rails and a chain or cable. Lifting shall be done by portable hoist. The pumps shall discharge to a special self-locking suction elbow permanently mounted to the wet well floor.

The pull up design shall allow maintenance and repair of the pump and motor without personnel having to enter the wet well.

All field testing of the pump shall be conducted with the special elbow in place.

2.8 MANUFACTURE AND FABRICATION. All iron and steel parts which will be in contact with pumped liquid or which are submerged after installation, including the inside of the casing, the impeller, and the discharge nozzle, shall be shop cleaned in accordance with the coating manufacturer's recommendations and painted with a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump. At least 1 quart (0.9 L) of the finish coat material shall be furnished with each pump for field touchup.

2.9 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 5.0 mils (0.125 mm).

2.10 SHOP TESTING. Each pumping unit shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall conform to the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be Level A, with no minus tolerance or margin allowed.

The Engineer, where specified, will witness shop tests of large pumps, inspect and check the testing equipment used, and observe the calibration of pressure gauges and transducers. The Contractor shall furnish the Engineer a plan and elevation sketch of the test setup showing the piping and instrumentation and shall notify the Engineer at least 14 days in advance of the time of each shop test. In the event the tests are conducted more than 75 miles (121 km) from Detroit, Michigan, the Contractor shall pay the expenses incurred by two of the Engineer's representatives in witnessing the test at no additional cost to the city. All the cost of witnessing tests by Engineer's representatives shall be paid by the Contractor in advance. The cost shall include travel, room, car rental, meals, and other incidental expenses.

If the pump fails to operate properly or fails to meet the specified conditions or requirements during testing, the pump manufacturer shall modify the pump and perform additional tests at no additional cost to the Engineer.

Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to the Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, bhp, pump efficiency, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements. All test points shall be clearly shown.

PART 3 - EXECUTION

3.1 INSPECTION. Examine bases and verify size of base and anchor bolt positioning. Rectify conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable for proper positioning, alignment, and anchorage.

3.2 INSTALLATION. Install all items in accordance with printed instructions of manufacturers, as indicated and specified. Make adjustments necessary to place equipment in satisfactory working order, at time of tests.

Include disassembly means to permit flow tests as specified below.

Each discharge base shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards.

3.3 FIELD QUALITY CONTROL. The general requirements for system testing, check out, initial start-up, certification, and instruction of plant personnel are contained in Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Additional requirements follow.

3.3.01 Acceptance Tests. Complete installations. Furnish labor, equipment and materials to conduct the tests. Give each pump a running test in the presence of Engineer to demonstrate satisfactory operation without vibration or overheating

Check centrifugal pump for head, capacity, RPM, and motor input (including supply power characteristics and line amps).

Correct all defects or replace defective equipment revealed and noted during test. Make necessary adjustments at the time of tests, at no additional compensation.

Repeat tests if necessary to obtain results acceptable to Engineer.

3.4 SPARE PARTS. A complete set of seals, O-rings, and gaskets, and one spare set of mechanical seals consisting of an upper and a lower seal, one spare set of each sized impeller and casing wear rings, one spare set of each size and type of bearings furnished and one of each sized impeller furnished shall be furnished.

End of Section

SECTION 11220

AXIAL HORIZONTAL SPLIT PUMPS

PART 1 - GENERAL

1.1 SCOPE. Contractor shall furnish all labor, materials, tools, equipment, and supervision required to install single stage, axially split case centrifugal pumps with shaft couplings and constant speed horizontal electric motors. Each pumping unit shall be provided with an electric motor. The pumps shall be used to pump potable water. The Contractor shall require the pumping units specified in this section be supplied by a single manufacturer.

These specifications shall be used together with Master Specification Section 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Costs resulting from errors due to failure to reference these sections will be borne by Contractor.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. In addition to the submittals required under Equipment General Provisions and Pump Applications General Requirements, submit the following data and drawings.

Efficiency at full, 3/4, and 1/2 load.

Guaranteed minimum efficiencies at 100 percent, 75 percent, 50 percent and 25 percent of full load.

Guaranteed minimum power factor at 100 percent, 75 percent and 50 percent of full load.

1.3 WARRANTY. The Contractor shall warrant against any defect in material, construction, or performance the Pumping Equipment and Appurtenances furnished under this specification including motors, drives, controls, etc. for a period of three (3) calendar years from the date of final acceptance.

Any defects occurring during this three (3) year period shall be reported by the Owner or his Representative to the Contractor, who shall make all necessary repairs at no cost to the Owner.

The Contractor shall warrant against any defect in material, construction or performance of the repair work for a period of two (2) calendar years from the date of acceptance of the repair work or for the balance of the three (3) year period specified above whichever is longer.

Defects in repair work that occur within this two (2) year period shall be reported by the Owner or his Representative to the Contractor who shall make necessary repairs at no cost to the Owner.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Refer to pump schedule for head and flow rate requirements.

2.1.01 Motor Design Requirements. Electric motors shall be squirrel cage induction type, shielded drip-proof, horizontal motors unless indicate otherwise. Motors shall be complete with motor base, and shall be suitable for operation on 230/460 volts, 3 phase, 60 hertz, electrical power. Unless indicated otherwise. Refer to Master Specification Sections 16220, General Purpose Induction Motors and 16150, Variable Frequency Drives for additional information.

Each pump shall be provided with a horizontal motor that is designed to drive the pump. Motors for variable speed pumps shall be rated for use on variable frequency drives (Nema MG-1, Part 31) with nameplate listed 10:1 speed range (6 – 60 Hz) Variable torque and include Inverter Grade Class F Insulation.

2.2 ACCEPTABLE MANUFACTURERS. The pumps shall be as manufactured by Ebara Pumps, ITT-AC, Ingersoil-Dresser Pump, Patterson Division of Banner Industries, Worthington Pump Division of Dresser Industries, or equal.

2.3 PUMP CONSTRUCTION.

2.3.01 Casing. The pump casing shall be manufactured from materials specified in Paragraph 2.3.10 or 2.3.11 herein as applicable and shall be tested at a hydrostatic pressure of 200 psi (1,380 kPa). The casing shall be provided with ribs and supporting sections. The material of construction and the structural design of the casings shall be subject to the approval of the Engineer. The bearing bracket shall be cast integrally or separate with the lower half casing. The upper half casing shall be fitted with lifting lugs or eye bolts. The casing shall be provided with all necessary taps for vents, drain plugs, lubrication seal water and suction and discharge gauge connections. The suction and discharge connections shall be ASA standard flanges of size and rating shown on drawings.

The flanged joint between the upper and lower halves of the casing shall be provided with dowels, located at diametrically opposite points of the flange to ensure proper alignment. The dowels shall be tapered and provided with a threaded part and hexagon nut at the large end to facilitate their withdrawal.

2.3.02 Impeller. The impeller shall be manufactured from materials specified in Paragraph 2.3.10 or 2.3.11 herein as applicable and of the double suction type. The impeller shall be dynamically balanced and mounted on the shaft with a single key which extends beyond the impeller hub locking the impeller and shaft sleeves against rotation on the shaft.

2.3.03 Wearing Rings. The casing shall be fitted with renewable wearing rings manufactured from materials specified in Paragraph 2.3.10 or 2.3.11 herein as applicable and designed to provide a smooth flow of water into the impeller eye. The casing ring shall be provided with a positive means of preventing rotation. The impeller shall also be fitted with removable wearing rings held in place by set screws or anti rotation lugs. The rings shall be machined for a running fit to minimize the leakage of water from the discharge to the suction side of impeller, and to maintain high sustained efficiency.

2.3.04 Shaft and Sleeves. The pump shaft and sleeves shall be manufactured from materials specified in Paragraph 2.3.10 or 2.3.11 herein as applicable. The shaft shall be accurately machined and ground over its entire length. The shaft shall be protected from wear and erosion in the pump by removable sleeves. The sleeves shall be keyed to the shaft with the same key extended from the impeller and held in place by an approved method water-tight with the impeller hub. Splash collars or deflectors shall be provided to prevent water from the stuffing boxes from running into the bearings.

2.3.05 Bearings. The pump bearings shall be manufactured from materials specified in Paragraph 2.3.10 or 2.3.11 herein as applicable.

The inboard pump bearing shall be of the radial sleeve, ring oiling type. The bearings shall consist of shell lined with grade two (2), tin base babbitt. Babbitt adhesion shall not be less than 95%. The bearing shall be accurately fitted to the shaft and grooved for thorough and uniform lubrication. They shall be split to permit their removal without disturbing the shaft. The bearing housings shall be designed to prevent leakage of oil and entrance of dust, and shall contain a large oil well with an adequate settling chamber.

Each oil well shall be equipped with an approved gurarded glass sight gauge and a plugged drain cock. Each pump shall be equipped with combination of radial and thrust bearing at the outboard which shall be designed to withstand all unbalanced axial thrust that may be imposed on the pump. The thrust bearing shall be as manufactured by Kingsbury and shall be furnished with Kingsbury Housing Model-CH.

The pump shall be equipped with an independent, two (2) oil ring lubrication system, which shall provide continuous, automatic flood lubrication of this thrust bearing.

The bearing temperatures shall not exceed 60°F above an ambient temperature outside the housing of 100°F.

Both inboard and outboard bearings shall be provided with Water Cooling System suitably designed to meet this requirement. The inboard and outboard sleeve bearings shall be provided each with one (1) RTD and the outboard thrust bearing shall be provided with two (2) RTDs to monitor the temperatures.

The RTDs shall be inserted in the bearings in such a manner to permit their removal and replacement easily, without disassembling the bearings as detailed on the drawings and as per bearing manufacturers recommendations.

2.3.06 Stuffing Box. Stuffing boxes shall be water sealed, and shall be designed to insure tight packing without excessive wear or friction on the shaft and to prevent air leakage into the pump under all conditions of operation. Refer to Paragraph 2.3.10 or 2.3.11 as applicable.

The stuffing box shall be complete with 316 stainless steel sleeve, 316 stainless steel pit lantern rings, split type adjustable 316 stainless steel glands with all necessary lattice braid packing. The stuffing box shall be provided with an inside liner of 316 stainless steel. Each split lantern ring shall have two ¼-20 threaded holes for ease of removal. Drip pockets shall be provided under glands and shall have tapped drains for piping away leakage. Suitable connections shall be provided for gland seal cooling from the casing as well from the external high pressure water source.

2.3.07 Baseplate. The pump and driver should be mounted on a one piece fabricated steel baseplate with provision to collect leakage or the pump casing shall be provided with machined supporting feet designed and located as approved by the Engineer. The supporting feet shall have adequate strength to resist all loads that may be imposed on the pump.

Each pump shall be equipped with approved sole plates made of ductile iron or fabricated from steel plates from single stock of not less than 1 ½ inches in thickness, and shall be provided with approved shear ribs, a finished surface on which the pump shall be mounted, and 1/8 inch shims between this surface and the pump supporting feet. The sole plates shall be designed to be bolted and grouted to concrete base.

The sole plates shall be machined on both sides to a smoothness not greater that 63 RMS micro inches. The bottom of the sole plates shall be painted with epoxy primer.

Each pump shall be doweled to support with tapered dowel pins in approved locations. Dowel pins shall be made of steel at least ¾ inch in diameter and provided with a threaded part and hexagon nut at the large end to facilitate removal.

The Pump Manufacturer shall furnish, a full scale template which indicates anchor bolts locations. The template shall be constructed from ASTM A36 Steel Plate and shall be shipped to the jobsite with the anchor bolts, minimum sixteen (16) weeks prior to the shipment of the pump.

2.3.08 Flexible Coupling. Each pump shall be coupled to its drive motor by means of an all steel type flexible coupling. The coupling shall be of the self-aligning, double engagement, lubricated, limited end float type designed to be moisture and dust proof similar to limited end float coupling size #5.0 fast type “HBPL” with phenolic spacers as manufactured by Kopflex, Inc.

2.3.09 Data Plates. All data plates shall be of stainless steel suitably attached to the pumps. Data plates shall contain:

Manufacturer’s name.

Pump size, type, and model.

Serial number.

Maximum speed.

Impeller diameter.

Capacity.

Head rating.

Other pertinent data identified by manufacturer.

A special data plate shall be attached to the pump frame that shall contain identification of frame and bearing numbers.

2.3.10 Pump Materials. The materials of construction for different parts of large pumps (40 MGD, or more) shall conform to the following reference standards. Any alternative standards require approval of the Engineer.

PART	MATERIAL
Casing – Lower Half or Upper Half	Cast Steel ASTM A216/A216, Latest Revision, Grade WCB
Impeller	Stainless Steel ASTM A743-CF3M
Shaft	Alloy Steel ASTM 434 Class BC
Wear Ring – Casing	Stainless Steel ASTM A747-CB7CU-1
Wear Ring – Impeller	Stainless Steel ASTM A743 –CF3M
Packing	Graphite Impregnated
Shaft Sleeve	Stainless Steel ASTM A747-CB7CU-1
Bearing – Inboard	Sleeve (MFG, STD)
Gland	Stainless Steel ASTM A743-CF3M
Bearing – Outboard	Kingsbury with Sleeve (MFG, STD)
Nut – Shaft Sleeve	Stainless Steel
Locknut	Steel (MFG, STD)
Lantern Ring	Stainless Steel ASTM A240-316
Bearing Housing – Inboard	Cast Iron – ASTM A48 CLASS 30
Impeller Key	AISI 420 Stainless Steel
Bearing Housing – Outboard	Cast Iron – ASTM A48 CLASS 30
Bearing Cover – Inboard	Cast Iron – ASTM A48 CLASS 30
Deflector	Aluminum (MFG, STD)
Bearing Cap – Inboard	Cast Iron – ASTM A48 CLASS 30
Stuffing Box Bushing	Stainless Steel ASTM A240-316
Shaft Collar	Steel (MFG, STD)
Bearing Cover – End	Steel (MFG, STD)
Seal Piping	Steel (MFG, STD)

For above items, provide Ductile Iron instead of Cast Iron if available or if owner requests.

2.3.11 Pump Materials. The materials of construction for different parts of small pumps (less than 40 MGD) shall conform to the following reference standards. Any alternative standards require prior approval of Engineer.

STANDARD MATERIAL HORIZONTAL SPLIT CASE PUMP	
PART	**MATERIAL**
CASING – LOWER HALF	DUCTILE IRON ASTM A536-CLASS 60-40-18
CASING – UPPER HALF	
IMPELLER	STAINLESS STEEL ASTM A743-CF8M
SHAFT	STAINLESS STEEL ASTM A276-316
WEAR RING – CASING	STAINLESS STEEL ASTM A743-CA40
WEAR RING – IMPELLER	STAINLESS STEEL ASTM A743-CA15
PACKING	GRAPITE IMPREGNATED
SHAFT SLEEVE	STAINLESS STEEL ASTM A743-CA15
BEARING – INBOARD	SLEEVE (MFG. STD)
GLAND	STAINLESS STEEL ASTM A743-CD8M
BEARING – OUTBOARD	SLEEVE – KINGSBURY (MFG. STD)
NUT – SHAFT SLEEVE	STAINLESS STEEL
LOCKOUT	STEEL (MFG. STD)
LANTERN RING	STAINLESS STEEL ASTM A240-316
BEARING HOUSING – INBOARD	CAST IRON – ASTM A48 CLASS 30
BEARING HOUSING – OUTBOARD	CAST IRON – ASTM A48 CLASS 30
DEFLECTOR	ALUMINUM (MFG. STD)
BEARING CAP – INBOARD	CAST IRON – ASTM A48 CLASS 30
STUFFING BOX BUSHING	STAINLESS STEEL ASTM A240-316
SHAFT COLLAR	STEEL (MFG. STD)
BEARING COVER – END	STEEL (MFG. STD)
SEAL PIPING	COPPER TUBING

For above items, provide Ductile Iron instead of Cast Iron if available or if owner requests.

2.3.12 Hardware. All machine bolts, nuts and capscrews shall be of the hex head type. Hardware (or parts) requiring special tools or wrenches shall not be used.

2.4 MOTOR CONSTRUCTION. Pump maximum horsepower and speed ratings shall not overload the motor at any point on the operating curve. Motors shall be as specified in Master Specification Section 16220, General Purpose Induction Motors.

2.5 SHOP TESTING. Each pump shall be fully tested on water at the manufacturer's plant before shipment. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Certified copies of test curves shall be submitted to contractor. The Standard of the Hydraulic Institute shall govern the procedures and calculations for these tests. The limits of vibration as set forth in the Standards of the Hydraulics Institute shall govern or at a minimum of 0.0196 in/sec velocity.

PART 3 – EXECUTION

3.1 INSTALLATION. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints greater that .002 is observed, piping shall be adjusted to fit properly.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. Startup and Testing shall be performed in accordance with Master Specification Section 11050, Equipment General Provisions. Pumping operation shall be adjusted as required to provide the appropriate flow conditions.

3.3 SPARE PARTS.

3.3.01 Spare Parts. The contractor shall furnish the following spare parts.

1 Impeller of each size provided.

2 Sets of Gaskets, O-Rings, etc. for each pump.

2 Sets, Each Type of Bearings.

1 Impeller Hub or Shaft Sleeve for each size provided.

1 Each, Each Type and size of Coupling.

2 Sets, Complete replacement all packing

1 Each, Each Type and size of Wear Rings

1 Each, Stuffing Box Gland split with Bronze Bolts and Nuts

1 Set of each size of Motor Bearings

End of Section

SECTION 11300

DRY PIT SOLIDS HANDLING PUMPS

PART 1 - GENERAL

1.1 SCOPE. Contractor shall furnish all labor, materials, tools, equipment, and supervision required to install vertical, dry-pit type solids handling wastewater pumps with extended shafting, shaft couplings, intermediate steady bearings, and vertical electric motors located on the grade floor. Each pumping unit shall be provided with an electric motor.

These specifications shall be used together with Master Specification Section 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Costs resulting from errors due to failure to reference these sections will be borne by Contractor.

1.2 QUALITY CONTROL.

1.2.01 Testing. In addition to the submittals required under Equipment General Provisions and Pump Applications General Requirements, the manufacturer shall, at no cost to the Owner, have each pump individually tested for the operating ranges defined on the pump schedule. Pumps shall be factory tested in accordance with Hydraulic Institute Standard and a Certified Test Curve shall be provided to the Engineer. Where specified, pumps shall be tested in the presence of the Owner, facility superintendent, and the design engineer at the cost of the pump manufacturer. Testing shall include but is not limited to Certified Shop Test and Field Acceptance Test.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. In addition to the submittals required under Equipment General Provisions and Pump Applications General Requirements, submit the following data and drawings.

Guaranteed minimum motor efficiencies at 100 percent, 75 percent and 50 percent of full load.

Guaranteed minimum motor power factor at 100 percent, 75 percent and 50 percent of full load.

Pump and motor cross sections, identifying all parts and materials.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Refer to pump schedule for horse power, head and flow rate requirements.

2.1.01 Shafting Design Calculations. Calculations shall be submitted to determine both a lateral and torsional critical speed analysis of the entire shafting assembly including the motor, the shafting, and the pump to identify that the first lateral critical speed shall be at least 25% above the maximum pump speed. Other exciting frequencies such as universal joint and vane-passing excitation shall also be avoided by placing these at least 20% above or below running RPM. No torsional natural frequency shall occur within a range extending from 20% below to 20% above any existing resonant frequency.

The drive shaft assembly shall be capable of withstanding the applied torque produced by the motor with a safety margin of no less than 2 times over the expected motor peak torque covering the entire range and speed specified. The driveshaft assembly shall be designed to operate below its critical speed. The 1/2 critical speed and potential excitation by impeller vanes shall also be avoided.

2.1.02 Motor Design Requirements. Each pump shall be provided with a shielded drip proof, solid shaft, vertical high-thrust motor that is designed to drive the pump and to support the weight of the suspended shafting. Motors for variable speed pumps shall be rated for use on variable frequency drives (Nema MG-1, Part 31) with nameplate listed 10:1 speed range (6 – 60 Hz) Variable torque and include Inverter Grade Class B Insulation.

2.2 ACCEPTABLE MANUFACTURERS. The pumps shall be ITT A-C pump type NSWV, Fairbanks Morse, Morris Pumps, Vaughn, or approved equal.

2.3 PUMP CONSTRUCTION.

2.3.01 Casing. The pump casing shall be ductile iron of sufficient strength, weight and metal thickness to insure long life, accurate alignment, and reliable operation. The volute shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller and provide smooth unobstructed flow. A large clean-out opening with removable cover, having its interior surface matching the volute contour, shall be located on the casing at the impeller centerline, to allow access to interior of the impeller. The casing shall be split perpendicular to the shaft, with removable suction piping and stuffing box cover and bearing frame. Machined fits for these parts shall be accurately aligned and identical so that casing may be installed for either clockwise or counterclockwise direction of rotation. The casing shall be so arranged that the impeller may be removed without disturbing either suction or discharge piping.

2.3.02 Casing Connections. The discharge flange shall be ANSI 125-psi () flat face. One of the taps in the discharge nozzle shall serve as a vent. A 1 inch (2.5 cm) diameter tap shall be provided on the discharge vent as a pressure gauge connection.

The pump discharge nozzle shall be capable of rotating to any one of eight discharge positions for each direction of rotation.

2.3.03 Suction Cover. The suction cover shall be removable to allow for access to the impeller. It shall be made of ductile iron. A 1/4 inch (6 mm) IPS tap shall be provided next to the suction flange. The suction flange shall be ANSI 125 pound flat faced.

A replaceable 11.5%-14% chrome steel wear casing plate shall be furnished. It shall provide 1/4 inch (6 mm) minimum wear and shall be installed with its wear surface parallel to the end of the impeller inlet.

2.3.04 Impeller. Impeller shall be single-suction enclosed type with 2 vanes, made of ductile iron. Impeller shall be particularly designed with smooth water passages to prevent clogging by stringy or fibrous materials, and shall be capable of passing solids having a maximum sphere size of not less than 4 inch (10.2 cm). Impeller shall be dynamically balanced. Impeller shall have a tapered bore and shall be keyed and secured to the shaft by a 18-8 stainless steel nut locked in placed and shall be readily removable without the use of special tools.

Pump shall have provisions for adjustment of axial clearance of impeller. This adjustment shall be made through the use of shims placed between the frame and outboard bearing housing.

A replaceable 11.5%-14% chrome steel "L" shaped impeller wear ring shall be provided. Ring shall be mounted on impeller to provide a renewable surface opposite the suction cover wear plate.

2.3.05 Stuffing Box Cover and Stuffing Box. The stuffing box cover shall be made of ductile iron with integral stuffing box. Stuffing box shall consist of 5 rings of graphited yarn/non-asbestos packing, teflon seal cage and a split-type gland to permit easy removal and access to packing. Sealing liquid connection to stuffing box shall be tapped in a convenient location. Ample space shall be provided for repacking the stuffing box. The stuffing box shall have a ¾ inch (2 cm) connection to drain leakage from gland. Mechanical seals may be requested by the Engineer.

2.3.06 Shaft. Pump shaft shall be high-strength carbon steel, AISI #1045 minimum, accurately machined, tapered at the impeller end, and of sufficient size to transmit full driver output. It shall be protected from the pumped liquid by a shaft sleeve in the Mechanical Seal area. A seal shall be provided by a synthetic rubber "O" ring, between the shaft and shaft sleeve to prevent leakage of pumped liquid out and/or air into the pump. (For packed pump only)

2.3.07 Shaft Sleeves. Renewable shaft sleeves shall be of a corrosive-resistant 400 Series stainless steel with a 500 Brinnell hardness. The sleeve provided shall extend through the stuffing box and under the gland.

2.3.08 Bearing Frame and Bearings. Pump bearing frame shall be one-piece ductile iron construction, Frame shall be provided with a ductile iron bearing housing at the outboard end, and a ductile iron end cover at the inboard end. Both ends of the frame shall be provided with lip type grease seals and labyrinth type deflectors to prevent the entrance of contaminants. Bearing frame shall be designed so that complete rotating element can be removed from the casing without disconnecting piping.

Bearings shall be designed for (100,000 hours for 24 hour per day pumps) minimum life at 50% of B.E.P. Radial inboard bearing shall be roller type, suitable for all loads encountered in the service conditions. Axial thrust outboard bearings shall have an outboard bearing arrangement consisting of one deep groove ball bearing to take the radial loads and one angular contact bearing to take axial loads.

Bearings shall be grease-lubricated with provisions for the addition and relief of grease. Bearings shall be provided with extended lubrication lines, attached to the bearing frame, to permit lubrication of all bearings by an operator standing on the pump floor.

2.3.09 Pump Drive Support Pedestal Base and Elbows. Each pump shall be provided with a ductile iron base to contain the suction reducing elbow and to provide a rigid base for anchoring the pump. Elbow may be dependent on pump layout.

Each pump shall be provided with a ductile iron reducing suction elbow which is bolted directly to the pump suction flange. A clean-out hand hole shall be provided with a removable cover of the largest possible size in the suction cover. A 1/4 inch (6 mm) tapped hole for gauge connection shall be provided in the suction cover. The pump suction connection shall be a 24 inch (61 cm) diameter.

2.3.10 Rotation. Each pump shall be arranged to rotate clockwise or counterclockwise as shown on the Drawings. Rotation direction is based on direction viewed from driver end.

2.3.11 Data Plates. All data plates shall be of stainless steel suitably attached to the pumps. Data plates shall contain:

Manufacturer's name.

Pump size and type.

Serial number.

Maximum speed.

Impeller diameter.

Capacity.

Head rating.

Other pertinent data identified by manufacturer.

A special data plate shall be attached to the pump frame that shall contain identification of frame and bearing numbers.

2.3.12 Hardware. All machine bolts, nuts and capscrews shall be of the stainless steel hex head type. Hardware (or parts) requiring special tools or wrenches shall not be used.

2.4 SHAFT CONSTRUCTION. Universal joint type intermediate shafting shall be provided to transmit power between the motor and the pump.

Each section of shafting shall consist of one "A" section just above the pump and one or more "B" sections as shown on the Drawings. The "A" Section shall have a telescoping splined slip member which will permit removal of the pump shaft and impeller without removing any section of intermediate shafting. The "B" section can be provided in multiple numbers to allow for the pump to be placed at a non-angling elevation.

Universal joint bearings shall provide a minimum AFBMA L-10 bearing life of 100,000 hours sized at maximum horsepower and maximum RPM.

Intermediate shafting shall be manufactured utilizing metallic DOM tubing only.

Shafting shall be precision dynamically balanced to 1/2 ounce inch per 10 pounds (36 gram cm per 4.53 kg) of shaft weight per end. Units shall be balanced at the maximum running RPM. The shafts shall be balanced as a unit and match marked to ensure proper in-field installation.

Shafting manufacture shall have complete vibration diagnostic equipment and trained personnel to test shafting and system components should they be required to eliminate any vibration which might occur at start-up.

Safety guards shall be provided as detailed on the Drawings. Safety guards shall be manufactured in two semi-circular halves rigidly formed over metal rods. Mounting fixtures shall be provided at the pump, each floor and ceiling as applicable. Safety guards shall be galvanized after fabrication.

Bearing pedestal stands or supports shall be provided as detailed on the Drawings. They shall be rigidly mounted so that their natural frequency is 4 times greater than the running speed (RPM) forcing frequency.

Intermediate steady bearings where required shall be manufactured with an AFBMA L-10 life not less than 100,000 hours and shall be grease lubricated and self-aligning with seals to prevent contamination by dust or moisture. Bearings shall be Dodge, Link, Belt, Torrington or equal. Where grease points are inaccessible, lube lines shall be extended to bearings.

2.5 MOTOR CONSTRUCTION. Pumps shall have maximum horsepower and speed ratings noted hereinafter and shall not overload the motor at any point on the operating curve. Motors shall be as specified in Master Specification Section 16220, General Purpose Induction Motors.

2.6 SHOP TESTING. Each pump shall be fully tested on water at the manufacturer's plant before shipment. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to property establish the performance curve. Certified copies of test curves shall be submitted to contractor. The Standard of the Hydraulic Institute shall govern the procedures and calculations for these tests. The limits of vibration as set forth in the Standards of the Hydraulics Institute shall govern. Tests shall be conducted with Owner present if so directed.

PART 3 – EXECUTION

3.1 INSTALLATION. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to fit properly.

3.2 SPARE PARTS. The contractor shall furnish the following spare parts:

2 Pump Shaft Sleeves of each size provided.

2 Sets Casing and Impeller Wear Rings of each size provided.

6 Sets Spare Packing

2 Sets of Pump Bearings of each size provided.

2 Sets of Shaft Couplings of each size provided.

2 Intermediate Shaft Bearings of each size provided.

2 Sets of Motor Bearings of each size provided.

1 Impeller of each size provided.

End of Section

SECTION 11310

SELF PRIMING PUMPS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous, self-priming, constant or variable speed centrifugal pumping units designed to handle raw, unscreened, domestic sanitary sewage.

These specifications shall be used together with Master Specifications Sections 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Any costs resulting from errors due to failure to reference these sections will be borne by Contractor.

1.2 QUALITY ASSURANCE. Each pump casing shall be hydrostically tested to 1.5 times maximum shut-off pressure by manufacturer. Each assembled pump shall be fully tested on water and have curves plotted to determine the rated capacity of each pump in accordance with the Hydraulic Institute standards

1.3 SUBMITTALS.

1.3.01 Drawings and Data. In addition to the submittals required under Equipment General Provisions and Pump Applications General Requirements, submit the following data and drawings.

Cross Section Showing Parts numbers and all materials of construction

Type of coupling

Motor efficiency at full load and rated pump condition

Number of permissible motor starts per hour under specified conditions

Motor insulation class/temp rise

Motor enclosure and type

Motor Voltage

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Pumps shall be horizontal, self priming, centrifugal pumping units used to convey water, wastewater and other water based liquids to the points of discharge indicated on the Drawings.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each pumping unit shall be designed for the operating conditions indicated on the Drawings and below. Each pumping unit shall be designed so that reverse rotation due to reverse flow will not cause damage to any component. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergences.

2.2.01 Solids Handling Capability. All internal passages, impeller vanes, and recirculation ports shall pass a minimum 3 inches (7.6 cm) spherical solid or as shown in Drawings. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted.

2.2.02 Reprime Performance. During unattended operation, the pump shall retain adequate liquid in the casting to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required. Pump shall reprime 15 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump shall reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition.

2.3 ACCEPTABLE MANUFACTURERS. Provide products of Gorman-Rupp Company or equal.

2.4 PUMP MATERIALS. Provide pumping units as specified below unless indicated otherwise on the Drawings.

Casing, frame, seal plate, bearing housing and cover plates	Ductile Iron, ASTM A48 Class 30
Removable Impeller	65-45-12 Ductile Iron
Replaceable Wear Plate	Type 1018 Carbon Steel
Shaft	Type AISI 41L40 steel
Shaft Sleeve	Type 4130 steel
Mechanical Seal	Oil lubricated double floating, self aligning seal with tugsten carbide rotating and stationary seal faces and 316 stainless steel spring.
Bearings	Antifriction open single ball bearings

Base	Fabricated steel
Check Valve	Molded Neoprene with integral steel and nylon reinforcing

2.5 PUMP CONSTRUCTION.

2.5.01 Casing. The casing fill port and pump interior shall have quick opening inspection covers retained by hand nuts. The priming recirculation port in the volute shall pass a 3 inch (7.6 cm) diameter sphere or other size as specified. The pump rotating assembly including the impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing shall be removable as a single unit without disturbing the pump casing or piping.

The nozzle flanges shall have ANSI Class 125 drilling. Pipe-tapped openings shall be provided for draining, priming, and venting the casing.

2.5.02 Impeller. The impeller shall be a one piece, two vane, semi open, non clog casting with integral pump vanes on the back shroud completely machined on all exterior surfaces and dynamically balanced. The impeller shall thread onto the shaft and be secured with a lockscrew and conical washer.

The interior impeller water passages shall have uniform sections, smooth surfaces and be free from cracks and porosity and shall pass a sphere not less than 4 inches (10.1 cm) in diameter.

2.5.03 Shaft and Shaft Sleeves. The shaft shall be completely machined. The shaft shall be provided with a replaceable sleeve extending from the impeller through the seal area. The sleeve shall be positively locked against rotation and axial movement and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly of the shaft, total runout shall not exceed 0.002 inch (0.005 mm).

2.5.04 Check Valve. A check valve shall be located in the suction side of the pump as an integral part of the housing. The check valve shall be removable without disconnecting the suction piping.

2.5.05 Bearings. Bearings shall be anti-friction ball or tapered roller type of proper size and design to withstand all radial and thrust loads expected during pump operation. Bearings shall be oil lubricated from a dedicated oil reservoir. Bearings shall have an AFBMA L_{10} rating of not less than 50,000 hours at the most severe loads imposed by the specified continuous duty conditions. The pump shaft speed shall not exceed the bearing manufacturer's limitations.

2.5.06 Accessories. The pump shall be provided with lifting eye bolts or lugs;

plugged gage cock connections at the suction and discharge nozzles; tapped and plugged openings for casing and bearing housing vents and drains; and fittings for properly adding the lubricant. Constant level oilers shall be provided.

2.5.07 Frame Assembly. The frame assembly shall rigidly support the rotating element with two bearings. The outboard bearing shall carry both axial and radial loads. The assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall keep out contaminants and retain the lubricant and shall have adequate provisions for adding and flushing lubricant.

2.5.08 Flexible Coupling. The pump coupling shall have a horsepower rating 1.5 times the motor nameplate horsepower when the misalignment is within the manufacturer's tolerance limit. Coupling design shall permit removal of the pump rotating element without disconnecting the piping, moving the drive unit, or axial movement of the coupling halves on the shaft.

2.5.09 Base plates. Base plates shall be provided with adequate openings for grouting and venting. Base plates shall provide for tapered dowels to maintain alignment of pump and motor.

2.6 DRIVE UNITS.

2.6.01 Electric Motors. Each pump shall be supplied with an electric motor. Each motor shall be squirrel-cage induction type, horizontal, shielded drip proof, and rated 230/460 volts, 3 phase, 60 Hz. Motors powered from variable frequency drives shall be rated for inverter duty in conformance with NEMA MG1 Part 31. The maximum brake horsepower of the pumps shall not exceed 90% of motor nameplate horsepower exclusive of service factor. Electric motors shall conform with Master Specification Division 16.

2.6.02 Variable Speed Drives. Variable frequency drives, where specified, are furnished under Master Specification Section 16150, Variable Frequency Drives.

2.7 CONTROLS. The pump controls shall be as shown on the Drawings and electrical schematics and shall be installed under Master Specifications Division 16 in accordance with Master Specifications Division 17, unless indicated otherwise.

2.8 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak-to-peak) as measured at any point on the machine shall not exceed 4.5 mils (0.11 mm) and that of the shaft measured at the face of the stuffing box shall not exceed 2.0 mils (0.05 mm).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 – EXECUTION

3.1 INSTALLATION. Each pumping unit shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. The sub base shall then be grouted in place using non-shrinking grout. Installation procedures shall be as recommended by the pump manufacturer, the Hydraulic Institute Standards, and as required herein. A concrete base shall be provided as required. Flanged connections to pumps are specified Master Specification Division 15, Mechanical.

The pump base shall be grouted after initial fitting and alignment but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. Piping stresses shall not be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joint is observed, piping shall be adjusted to proper fit.

Shimming between machined surfaces will not be permitted.

3.2 FIELD QUALITY CONTROL. After initial startup under the supervision of a qualified representative of the pump manufacturer, a preliminary running-in period will be provided for the Contractor to make field tests and necessary adjustments.

The Owner will then operate the pumps for a period of 30 consecutive calendar days. At the end of the specified period of operation, the pumping unit will be accepted if, in the opinion of the Engineer, it has operated satisfactorily without excessive power use, wear, or need for lubrication, or requiring undue attention; and if all its rotating parts operate without excessive vibration or noise at any operating head, including shutoff.

3.3 SPARE PARTS. The contractor shall also furnish the following spare parts as well as any others agreed to during submittal process:

1 Impeller of each size provided.

1 Wearplate, each pump

1 Set of Mechanical Seals for each Pump.

1 Set, Each Type and size of Bearings.

End of Section

SECTION 11320

RECESSED IMPELLER PUMPS

PART 1 – GENERAL

1.1 SCOPE. This section covers recessed impeller pumps for transporting sewage or slurries with or without grit and/or sludge generated from water, storm water and wastewater treatment processes. Pumps shall be of a severe duty, recessed cupped impeller design suitable for use in sludge and grit applications with a 20 year performance life.

These specifications shall be used together with Master Specification Sections 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Costs resulting from errors due to failure to reference these sections will be borne by Contractor.

1.2 QUALITY ASSURANCE. The manufacturer shall test each pump casing hydrostatically to 1.5 times maximum shut-off pressure. Each assembled pump shall be fully tested on water and have curves plotted to determine the rated capacity of each pump in accordance with Hydraulic Institute Standards.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. In addition to the submittals required under Equipment General Provisions and Pump Applications General Requirements, submit the following data and drawings.

Type of coupling or belt drive

Motor efficiency at full, 3/4, and 1/2 load

Number of permissible starts per hour under specified conditions

Motor insulation class/temp. rise

Motor enclosure type

1.4 WARRANTY. The Contractor shall provide a guarantee from the manufacturer against mechanical failure due to materials and workmanship or abrasive wear under the original specified operating conditions for the pump liquid end (suction cover, casing, impeller, and rear liner). The guarantee shall include the replacement of the part for 5 years from the date of shipment. The liquid end guarantee shall be provided in certificate form, signed by an officer of the manufacturing corporation and listed in the submittal.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each pumping unit shall be designed for the operating conditions indicated on the drawings and below. Since these pumps will be used to pump abrasive grit and other solids, the pumps shall be specifically designed to both optimize wear resistance and then maintain hydraulic performance as wear occurs.

The pump(s) shall be of a fully recessed, cup type design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connection, so that solids are not required to flow through the impeller. All flow path clearances within the pump(s) shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

Minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.

The pump shall be designed to operate continuously for an extended period of time at any point in the specified operating range of the curve without cavitation, overheating, or excessive vibration. The motor nameplate horsepower rating shall not be exceeded by the pump brake horsepower requirements at any point of the specified operating range.

Each pumping unit shall be designed so that reverse rotation due to reverse flow will not cause damage to any component. The pump casing shall be reversible for right hand or left hand rotation without the need for changing the impeller or casing and shall be of sufficient strength and metal thickness to insure long life, accurate alignment, and reliable operation. The volute of the pump casing shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the discharge and provide smooth, unobstructed flow. The casing shall have a separate and removable suction cover, rear liner and stuffing box cover.

The pump shall have a continuously rising head capacity from runout to shutoff. The pump’s head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.

Pumps shall be equipped with slotted raised-face flanges to receive 125 lb (56.7 kg) standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.

2.3 ACCEPTABLE MANUFACTURERS. Pumps shall be Wemco Pump Co. Model C, Morris Pump Co. Model 6100 or approved equal.

2.4 MATERIALS.

2.4.01 Parts Exposed to Abrasive Wear. The pump case, removable suction piece, impeller, and wear plate, shall be of all Ni-Hard material conforming to ASTM Designation A532 Class I, Type A, and be a minimum of 650 Brinell hardness for maximum wear resistance. Brinell values below this are not acceptable and will be rejected.

A removable wear plate of Ni-Hard shall be provided in back of the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing. The packing housing shall be a separate piece bolted to the bearing housing for ease of removal. Wear plates that incorporate a stuffing box are not acceptable.

2.4.02 Parts Not Exposed to Abrasive Wear. The bearing housing shall be cast iron ASTM A48, Class 35B.

Shaft shall be steel and comply with AISI 1045 H.R.

Shaft sleeve shall be hardened type 420 stainless steel conforming to ASTM A473, Grade CA-40 with a minimum hardness of 450 BNN.

Bearings shall be antifriction.

Base plate shall be fabricated steel

Anchor Bolts, Nuts, and Washers shall be stainless steel.

2.5 PUMP CONSTRUCTION.

2.5.01 Casing Assembly. The pump casing shall be of the two-piece radially split-type, with a separate and removable suction piece designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping. The casing shall be constructed so that it can be reversed for opposite rotation, and shall be of Ni-Hard. To insure a liberal wear allowance, the casing and suction piece shall be constructed, and the entire wet end weights shall be, as indicated on the Drawings or as specified.

Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the Owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the Engineer may at any time prior to final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection.

2.5.02 Impeller. The impeller shall meet ASTM A532, Class 3, Type A, be constructed of 650 Brinell Ni-Hard, and be specifically designed to maintain hydraulic pumping performance as wear occurs.

The impeller shall be of the single suction vortex design recessed into the rear wear liner and out of the flow path. The impeller shall be of a cupped shape with the impeller shroud fully encasing the tips of the impeller vanes preventing direct impingement of the pumpage on the wear liner or casing resulting in localized wear. Radical discharging impellers will not be accepted.

The shroud of the impeller shall incorporate pump out vanes for the purpose of maintaining a solids free area behind the impeller to decrease wear and extend the life of the stuffing box seal.

The impeller shall be straight bored and keyed to the pump shaft. The impeller shall be held in place by a recessed 18-8 SS impeller bolt and will be sealed front back with Buna-N O-rings to provide a dry shaft design. The impeller bore shall be directly through the homogeneous impeller material. The use of soft metal casting inserts which could break loose due to torque and fatigue associated with starting and stopping will not be accepted.

The cupped impeller shall be capable of being easily removed and remounted on the pump shaft without the use of special procedures to confirm impeller bore engagement. Designs which do not utilize a machined keyway for torque transfer shall not be acceptable.

Due to the size, shape and weight of the cupped impeller design, special tool shall be provided to assist with handling the impeller during maintenance.

The impeller shall provide the same hydraulic performance regardless of rotation.

2.5.03 Shaft and Shaft Sleeves. The shaft sleeve shall be of a hook style design and will extend from the impeller past the face of the stuffing box. The sleeve shall be sealed against the impeller with an o-ring to provide a dry shaft design. Sleeve designs that do not fully protect the shaft against the corrosive and abrasive effects of the pumpage will not be accepted.

The sleeve shall be keyed to the shaft to prevent rotation relative to the shaft.

The shaft shall be high strength, accurately machined and of sufficient size, with liberal safety factor, to transmit the maximum horsepower and loading from the impeller to the bearings when the pump is operating at the maximum allowable speed. The pump shaft shall be designed such that the maximum shaft deflection shall not exceed .002 inch (0.05 mm) at the stuffing box.

2.5.04 Stuffing Box Cover. The stuffing box cover shall be clamped between the rear liner and the bearing frame and will be provided with machined registered fits to assure true alignment with the pump shaft.

The stuffing box shall be suitable for either packing or mechanical seals. The stuffing box will be provided with two 3/8 inch (1.0 cm) NPT flush taps for piping arrangement flexibility and shall have a 4 bolt gland pattern.

The packed stuffing box shall be provided with 5 rows of packing, a Teflon lantern ring, a 316SS split gland and 316SS gland hardware.

A taperbore stuffing box shall be available as an option for use with single mechanical seals on abrasive services.

Ample room shall be provided for maintenance of the stuffing box. As a minimum the distance from the face of the stuffing box. As a minimum the distance from the face of the stuffing box to the first obstruction shall be 3 inch (7.6 cm).

2.5.05 Frame Assembly. The frame assembly shall rigidly support the rotating element with 2 bearings. The outboard bearing shall carry both axial and radial pump loads. The assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall keep out contaminants and retain the lubricant and shall have adequate provisions for adding and draining lubricant. The bearing frame shall be designed so that the complete rotating assembly can be removed without disturbing the suction and discharge piping.

2.5.06 Bearings. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing will be equipped with a pressure venting device and oil fill and drain taps. A built-in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum AFBMA L-10 life of 100,000 hours, without credit for any rear pump-out vanes to balance hydraulic thrust.

2.5.07 Mounting. Mounting shall be horizontal with V-belt drives between motor and pump. The pump supplier shall furnish and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions. The drive shall be of the “stationary control” variable speed type that allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.

An approved fiberglass belt guard shall be provided to safely enclose the V-belt. If metal guards are furnished, they shall be of all 316 stainless steel construction with suitable lifting eyes and handles to aid in removal.

2.5.08 Base plates. The pump manufacturer shall provide a common pump and motor base constructed of a minimum 3/8 inch (1.0 cm) thick fabricated steel, suitably reinforced to support the full weight of pump and motor. Base plates shall provide for tapered dowels to maintain alignment of pump and motor.

The pump supplier shall furnish and mount a separate, adjustable motor base so that the motor can be easily moved for V-belt tensioning and adjustment.

2.6 MOTORS. Electric motors shall be shielded drip proof type with sheave. Motor shall comply with Master Specification Section 16220, General Purpose Induction Motors-Procurement.

2.7 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 4 mils (0.1 mm).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be not less than 0.8 nor more than 1.3.

2.8 SHOP TESTING.

2.8.01 Hardness Testing. Before final shipment, a Brinell hardness test shall be conducted showing compliance to ASTM A532 and shall be submitted for approval. Each individual casting shall be Brinell tested at the manufacturer’s plant to ASTM Method E-10. Each casting shall be checked in a minimum of 2 places, in an area that is representative of casting thickness.

2.8.02 Performance Testing. All hydro and performance testing shall be completed prior to the application of any final paint and/or coating. All factory tested shall be in accordance with the standards of the Hydraulic Institute (latest edition). All testing is to be performed at the manufacturer’s facility using lab personnel, instrumentation and drives.

Hydrostatic testing shall be performed on the assembled pump with the liquid end components being held at a pressure of 150 psi, but not greater than the allowable mechanical seal pressure, for a period of not less than 30 minutes.

Performance testing shall include head, capacity and power readings at 8 points including the rated point, to determine the actual pump performance and efficiency. Performance testing shall establish that the pump is free of overheating, cavitation and excessive vibration over the specified conditions. A certified performance curve shall be completed after the test and included in the final data package.

A 30 day notice shall be given to the Engineer prior to the start of any witness testing.

2.9 ACCESSORIES. Each pump shall be provided with plugged gauge cock connections at the suction and discharge nozzles; tapped and plugged openings for casing drain; and appropriate fittings for adding bearing lubricant and seal water.

PART 3 – EXECUTION

3.1 INSPECTION. Examine bases and verify size of base and anchor bolt positioning. Rectify conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable for proper positioning, alignment and anchorage.

3.2 INSTALLATION. Each pumping unit shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards, and as required herein.

The pump base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3.3 FIELD QUALITY CONTROL. The general requirements for system testing, check out, initial start-up, certification and instruction of plant personnel are contained in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.4 FIELD TESTING. Field functional testing will be performed to insure proper mechanical operation at the job site. All testing to be used for performance evaluation shall be performed at the pump manufacturer’s facility.

3.5 SPARE PARTS. The contractor shall also furnish the following spare parts as well as any others agreed to during submittal process:

1 Impeller of each size furnished.

1 Set of Mechanical Seals for each Pump.

2 Sets of Gaskets, O-Rings, etc. for each pump.

1 Set, Each Size and Type of Bearings.

1 Each, Each Size and Type of Wear Ring

End of Section

SECTION 11330

PLUNGER PUMPS (SLUDGE)

PART 1 – GENERAL

1.1 SCOPE. This section covers plunger pumps for transporting sludge generated from wastewater treatment processes.

1.2 QUALITY ASSURANCE. Each pump shall be hydrostatically tested to 200 psig test pressure by manufacturer. Each assembled pump shall be fully tested on water and have data plotted to determine the rated capacity of each pump.

1.3 WARRANTY. The motor and reducer as a direct coupled unit shall be warranted for 2 years against defects in material and workmanship.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Plunger pumps shall be used to remove and transport sludge to the points of discharge as indicated on the drawings.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each pumping unit shall be designed for the operating conditions indicated on the drawings and below. Minimum hydrostatic test pressure shall be 200 psig (1,379 kPa). Pump performance shall be stable throughout the specified operating head range.

2.3 ACCEPTABLE MANUFACTURERS. Plunger pumps shall be ITT-Marlow, Komline-Sanderson Engineering Corp., or equal.

2.4 MATERIALS.

2.4.01 Plunger Pumps. Pump body, housing and valve chamber shall be Grey Iron No. 30 unless indicated otherwise. The connecting rods, eccentrics and drive/driven flanges shall also be cast iron.

2.5 PUMP CONSTRUCTION.

2.5.01 Pump Body Assembly. The pump body, housing, and valve chambers shall be of 30,000 psi (207 MPa) minimum cast iron, capable of 100 psi (689 kPa) working pressure and 200 psig (1,379 kPa) test pressure. The construction of the pump shall be such as to permit easy removal of the plunger and connecting rod without disturbing the piping or the main eccentric shaft. The plunger shall be Class 40 cast iron and shall be ceramic coated with a minimum coating thickness of .012 (0.3 mm) and minimum hardness of 65 Rockwell. The plunger surface shall also have a polished finish. Standard equipment shall include a 0.25 inch (6.4 mm) “snifter” valve on the suction side of the pump, and a 1-inch (2.5 cm) sampling valve on the discharge side.

2.5.02 Connecting Rods. The connecting rods, eccentrics and drive/driven flanges shall also be cast iron. The eccentric shall be provided with shear pin protection. The stroke length shall be adjustable with 11 stroke positions. Each eccentric shall be supported on each face with a flange and the plunger thrust shall be distributed over the main shaft. A hardened steel bushing shall be pressed into each adjusting position on the drive flange and a hardened steel bushing shall also be fitted on the eccentric to ensure a clean cut of the shear pin without damaging the cast iron.

The connecting rod shall be cast iron with the eccentric bearing liner as a separate removable insert, such that the connecting rod need not be removed to replace the liner. Bearing liner will be lubricated by a 5 ounce (141.7 g) manual sight feed oiler or automatic ball-type drop feed oiler.

2.5.03 Pump Shaft. The main pump shaft shall be of ground and polished high strength alloy steel and shall be supported by self-aligning bearings. The main shaft shall have a minimum tensile strength of 160,000 psi (1,1030,000 kPa) and a minimum weld strength of 130,000 psi (896,000 kPa). The pump drive shall transmit torque to only the pump shaft, eliminating all side loading stresses except for those that are transmitted by the plunger eccentric. A 1.5 safety factor of actual stress to shaft yield stress shall be maintained. A six figure mechanical revolution counter shall be provided and driven from the pump shaft

2.5.04 Stuffing Box. The stuffing box shall be equipped with a ½ inch (1.3 cm) “Leak Free” packing arrangement that includes a pilot ring, sealing ring and braided packing, lubricant, and hardware to ensure that very little or no stuffing box leakage will be present during the pump’s operation. Each stuffing box shall be equipped with an adjustable packing gland and 1inch (2.5 cm) drain connection. Also acceptable as an alternate to the leak free packing arrangement would be a plunger pac that includes a 1/2 inch (12.7 mm) urethane u-cup, Chevron packing rings and teflon rope.

2.6 DRIVE UNITS. Motor shall comply with Master Specification Section 16220, General Purpose Inductor Motors - Procurement.

2.6.01 Motor. The pumps shall be driven by a constant speed 1750 rpm motor of indicated Horse Power, direct connected to a single reduction, fully enclosed gear reducer drive. The motor shall be furnished for 3 phase, 60 hertz, 230-460 volt operation with TEFC construction. The gear drive shall be oil lubricated, and designed to distribute the stresses over a minimum of 60% of the gear faces. It shall have a minimum 1.5 service factor and be capable of handling 500% shock loads. For simplex and duplex pumps that incorporate a coupling between the reducer and the main shaft, the coupling shall be designed to handle high shock loading and torque reversal and prevent backlash and noise. Couplings shall be Rexnord Thomas AMR coupling, Falk Steelflex or equal.

2.6.02 Variable Speed Drivers. The pumps shall be driven by motor of indicated Horse Power, and mechanical variable speed drive, direct connected single reduction, fully enclosed gear reducer. The variable speed unit shall have a 10:1 speed ratio with an electric, remote speed control and tachometer generator with 2 speed indicators. Variable speed drive shall be US Varidrive or equal.

2.7 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 4 mils (0.1 mm).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be not less than 0.8 nor more than 1.3.

2.8 ACCESSORIES.

2.8.01 Valves. Each pump, as specified, shall be furnished with single or dual ball valves in series for each plunger on the suction and discharge side. The valve chambers shall have ball guide ribs beveled at the top and bottom to prevent clogging. The valve balls shall be urethane rubber ball valves with centralized metal cores at least 5-1/8 inch (13.0 cm) diameter. The valve seats shall be one piece, independent, fully machined 316 stainless steel plates that can be replaced without disturbing valve chambers or piping. Valve seat removal shall not require any special tools. Quick opening clamp type covers with “O” ring gaskets shall be provided for each valve chamber.

2.8.02 Air Chambers. Suction and discharge air chambers shall be of galvanized steel or 304 stainless steel with an air release valve included with each pump. Air chambers shall be a minimum of 30 inches (76.2 cm) high by 9 inches (22.9 cm) in diameter included on both the suction and discharge side of the pump to reduce pulsations. To reduce clogging, the air chambers shall have an area at the entrance of 12-1/2 square inches (80.6 square cm) that shall be maintained through to the manifold or adapter.

2.8.03 Gauges. A 4-1/2 inch (11.4 cm) compound suction gauge, reading 30 inches (76.2 cm) Hg to 15 psi (103.4 kPa), and a 4-1/2 inch (11.4 cm) discharge gauge, reading 0 to 40 psi (275.8 psi), shall be mounted on the air chambers. Gauges shall be provided with protective diaphragm seals with vent petcocks. Protective diaphragms shall be as manufactured by Red Valve or equal. Refer to Master Specification Section 15130, Indicating Devices.

PART 3 – EXECUTION

3.1 INSPECTION. Contractor shall examine bases and verify size of base and anchor bolt positioning. Rectify conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable for proper positioning, alignment and anchorage.

3.2 INSTALLATION. Contractor shall grout after initial fitting and alignment, but before final bolting of connecting piping the pump base. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3.3 FIELD QUALITY CONTROL. The general requirements for system testing, check out, initial start-up, certification and instruction of plant personnel are contained in Master Specification Section 01018, Equipment, Materials, Parts and Tools.

3.4 SPARE PARTS. The Contractor shall also furnish the following spare parts:

5 sets of packing

2 sets, each type and size of bearings.

1 eccentric shear pin.

1 eccentric bearing liver.

1 valve ball and seat, each type.

End of Section

SECTION 11340

DRY PIT HORIZONTAL CHOPPER PUMPS

PART 1 - GENERAL

1.1 SCOPE. Contractor shall furnish all labor, materials, tools, equipment, and supervision required to install dry-pit horizontal chopper pumps with shaft couplings and horizontal electric motors located in the dry pit.

The pump shall be specifically designed to pump wastewater with heavy concentrations of solids. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action. The pump shall have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease, hair balls, wood, paper products, and stringy materials without plugging, both in tests and field applications.

These specifications shall be used together with Master Specification Sections 11100, Pump Application General Requirements and 11050, Equipment General Provisions. Costs resulting from errors due to failure to reference these sections will be borne by Contractor.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. In addition to the submittals required under Master Specification Sections 11050, Equipment General Provisions and 11100, Pump Applications General Requirements, submit the following data and drawings.

Motor Efficiency at full, 3/4, and 1/2 load.

Guaranteed minimum power factor at 100 percent, 75 percent and 50 percent of full load.

Pump and motor cross sections, identifying all parts and materials.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Refer to pump schedule for head and flow rate requirements.

2.1.01 Motor Design Requirements. Electric motors shall be totally enclosed fan cooled (TEFC) solid shaft, horizontal motors suitable for operation with a variable frequency drive where specified. Motors shall be complete with motor base, and shall be provided for operation on 230/460 volts, 3 phase, 60 hertz electrical power. Motors shall be rated for use on constant torque variable frequency drives, where specified. The motors shall be supplied with necessary power and control wiring for integration into variable frequency drives.

2.2 ACCEPTABLE MANUFACTURERS. The pumps shall be Vaughn horizontal dry pit chopper pump type or equal.

2.3 PUMP CONSTRUCTION.

2.3.01 Casing. The pump casing shall be semi-concentric back pull-out design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb (68 kg) flanged centerline discharge. Casing shall be ASTM A536 ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. A 1/4 inch (6.4 mm) NPT pressure tap shall be included in the discharge flange.

2.3.02 Impeller. The impeller shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of 0.020" - 0.030" (0.51 - 0.76 mm) cold. Impeller shall be cast from ASTM A148 alloy steel, case hardened to minimum Rockwell C 60 and dynamically balanced. The impeller shall be threaded to the shaft and shall have no axial adjustments and no set screws.

2.3.03 Cutter Bar. The cutter bar shall be recessed into the pump bowl, with a funnel shaped inlet opening, and shall extend diametrically across entire pump suction opening. Cutter bar shall be cast from ASTM A536 ductile iron, hardened to minimum Rockwell 50. Replaceable shear bars shall be AISI 8620, case hardened to minimum Rockwell C 60.

2.3.04 Pump Shafting. The pump shaft and impeller shall be supported by ball bearings. All shafting shall be AISI 4140 heat treated.

2.3.05 Bearings. Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings. AFBMA L-10 bearings life shall be minimum 100,000 hours.

2.3.06 Bearing Housing. Shall be A536 ductile cast iron, and machined with piloted bearing fits for concentricity of all components. Bearing housing shall be oil bath lubricated with ISO Gr. 46 turbine oil and a side-mounted site glass to provide a permanently lubricated assembly. Viton double lip seals riding on stainless steel shaft sleeves shall be provided to seal each end of the bearing housing.

2.3.07 Stuffing Box. The stuffing box shall be a packing design with 5-ring packing, split Teflon lantern ring and water fitting. The system shall be provided with a 6-10 gallon/hour (22.7-37.9 L/hour) flush with clean filtered water. Seal water system shall be provided by the contractor and shall include a Rotometer and throttle valve.

2.3.08 Shaft Sleeve. Shaft sleeve shall be 316 SS (mechanical seal) with Nickel-Chrome-Boron coating (packing).

2.3.09 Inlet Seal. The pump assembly shall be mounted horizontally with a 150 lb (68.0 kg) standard inlet flange, cleanout, 1/4 inch (6.4 mm) NPT suction pressure tap, drain connection, and mounting feet.

2.3.10 Shaft Coupling. Bearing housing and motor stool design shall provide accurate, self aligning mounting for a C-flanged electric motor. Pump and motor coupling shall be T.B. Woods Sureflex or equal elastomeric type.

2.3.11 Rotation. Pumps shall be arranged to rotate clockwise. Rotation direction is based on direction viewed from driver end.

2.3.12 Data Plates. All data plates shall be of stainless steel suitably attached to the pumps. Data plates shall contain:

Manufacturer's name.

Pump size and type.

Serial number.

Maximum speed.

Impeller diameter.

Capacity.

Head rating.

Other pertinent data identified by manufacturer.

A special data plate shall be attached to the pump frame that shall contain identification of frame and bearing numbers.

2.3.13 Hardware. All machine bolts, nuts and capscrews shall be of the hex head type. Hardware (or parts) requiring special tools or wrenches shall not be used. (Note stainless steel hardware specified later)

2.4 MOTOR CONSTRUCTION. Pumps shall not overload the motor at any point on the operating curve. The motor nameplate horsepower rated shall exceed the brake horsepower requirements of the specified head and capacity conditions. Electric motors shall be as specified in Master Specification Section 16220, General Purpose Induction Motors - Procurement.

2.5 SHOP TESTING. Each pump shall be fully tested on water at the manufacturer's plant before shipment. Tests shall consist of checking the unit at its rated speed, head, capacity, efficiency and brake horsepower, and at such other conditions of head and capacity to properly establish the performance curve. Certified copies of test curves shall be submitted to contractor. The Standard of the Hydraulic Institute shall govern the procedures and calculations for these tests. The limits of vibration as set forth in the Standards of the Hydraulics Institute shall govern.

PART 3 – EXECUTION

3.1 INSTALLATION. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to fit properly.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. Startup and Testing shall be performed in accordance with Master Specifications Section 11050, Equipment General Provisions. Pumping operation shall be adjusted as required to provide the appropriate flow conditions.

3.3 SPARE PARTS. The contractor shall also furnish the following spare parts as well as any others agreed to during submittal process:

1 Impeller.

1 Cutter Bar Plate.

1 Shear Bar Insert.

1 External Cutter.

1 Set of Shims.

5 Sets of packing for each Pump.

2 Sets of Gaskets, O-Rings, etc. for each pump.

1 Set of Pump Radial and Thrust Bearings.

1 Shaft Sleeve.

End of Section

SECTION 11650

SUMP PUMPS

PART 1 – GENERAL

1.1 SCOPE. This section covers heavy duty submersible sump pumps used to pump water out of meter pit and building sumps.

1.2 GENERAL.

1.2.01 Governing Standards. Unless otherwise specified, the work of this Section shall conform to the applicable portions of the following Standard Specifications:

AFBMA - Anti-Friction Bearings Manufacturers Association

ANSI – American National Standards Institute

ASTM – American Society for Testing and Materials

HI USA – Hydraulics Institute USA

NEMA – National Electrical Manufacturers' Association

1.3 QUALITY ASSURANCE. Each pump casing shall be hydrostatically tested to 1.5 times maximum shut-off pressure by manufacturer. Each assembled pump shall be fully tested on water and have curves plotted to determine the rated capacity of each pump in accordance with the standard of HI USA.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit manufacturer's product data. This data should be included, unless otherwise directed, in a schedule shown elsewhere. The data and specifications for each unit shall include, but not be limited to, the following:

Name of manufacturer

Type and model

Rotative speed

Size of suction nozzle

Size of discharge nozzle

Net weight of pump

Complete performance curves showing capacity versus head, NPSH required, pump efficiency, and bhp

Submit shop drawings detailing installation, wiring, and controls. Drawings shall also show details of anchoring and identify type, length and diameter of anchors to be used. Submit Control Panel layout drawings showing details of all panel components, including ladder schematics, wiring diagrams and manufacturer's details and catalog cut sheets.

Submit Operation and Maintenance Manual, including parts list, control diagrams in ladder format, spare parts listing, and recommended schedule of inspection, cleaning and lubrication. Include manufacturer's recommended lubricants.

1.5 DELIVERY, STORAGE AND HANDLING. The Contractor shall transport and store all material and equipment in a manner to eliminate the possibility of damage, breakage or chipping.

1.6 WARRANTY. The pump manufacturer shall warrant the units being supplied to the Owner against defects in workmanship and material for a period of 1-1/2 years from the date of acceptance by Owner.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. Sump pumps shall be used to remove potable and storm water and other water based liquids as indicated on the drawings.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each pumping unit shall be designed for the operating conditions indicated on the drawings and below. Minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergences. Each pumping unit shall be designed so that reverse rotation due to reverse flow will not cause damage to any component.

2.3 ACCEPTABLE MANUFACTURERS. Submersible sump pumps from Peabody and Barnes, Hydromatic, Flyght, or equal are acceptable.

2.4 PUMP CONSTRUCTION. Casing assembly shall be stainless steel or cast iron. The impeller shall be cast iron, ductile iron, or 316 stainless steel as indicated. Contractor shall provide ductile iron for all cast iron upon Owner's request. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. Shaft shall be stainless steel. Suction and discharge ports shall be flanged connections. Pump shall have upper and lower heavy duty ball bearings and carbon/ceramic mechanical seals both permanently lubricated in an oil bath.

2.5 MOTORS. Motor shall be Class F with a maximum temperature of 310 degrees F (155 degrees C) and with dry running capability. Motor shall be permanently lubricated for extended service life. Also see Master Specification Section 16220, General Purpose Induction Motors - Procurement.

2.6 CONTROLS. Where applicable, the duplex type sump pumps shall be furnished with a NEMA 4X local control panel incorporating a magnetic-only adjustable circuit breaker type disconnect with overload and phase failure protection, and NEMA rated motor starters with thermal overload protection. An alternating relay shall be provided for pump lead-lag status alternation. All pilot devices shall be transformer type, 1-1/6 Inch (30 mm), oil-tight type. Relays should be 3 PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings. A 120 volt control power transformer with one secondary lead fused and the other grounded shall also be provided.

The duplex units shall have a control system consisting of four mechanical float switches located inside sealed, double walled NEMA type 6 floats of rigid plastic with a cable molded onto the end and a NEMA 4X local control panel. The pump control and alarm mechanical float switch assemblies shall be furnished with 20 foot (6 m) cables to be hardwired to the local control panel, a support pipe of compatible material, support brackets, and gas-tight cable clamps.

The duplex local control panel shall include, but shall not be limited to, the following:

Power ON/OFF selector switch

H/O/A selector switch for each pump

Start and Stop pushbuttons for each pump

Alarm Reset pushbuttons for each pump

“Running” pilot light (red – per pump), “Off” pilot light (green – per pump), “Power On” pilot light (white), “High Sump Level Alarm” pilot light (amber), “High-High Sump Level Alarm” pilot light (amber).

Elapsed Time Meter

Duplex receptacle

Terminal Strip

Normally closed contacts pre-wired to terminals for external connections to others corresponding to the following:

"Pump No.1 General Failure"

"Pump No.2 General Failure"

"Pump No.1 Running Status" (On; Off)

"Pump No.2 Running Status" (On; Off)

"Low Sump Level"

"High Sump Level"

"High-High Sump Level"

The first high level switch will alarm and start the lead sump pump. The lead and lag pump order shall be determined through an electric alternating relay. The second high level switch will alarm and start the lag sump pump if the liquid level continues to rise. The high-high level switch will alarm if the liquid level continues to rise with both sump pumps running. The low level switch will shut down both sump pumps.

2.7 ACCESSORIES. Each pump shall be provided with a seal water valve station as required for proper pump operation. The valve station shall include, but not be limited to, isolation valves, strainers, foot valves, pressure regulating device (optional), flow regulating device, flow indicator, pressure switch, pressure gauge or gauges, and flexible connector. Piping shall conform to the piping section. Pressure and flow setpoints shall be as recommended by the pump supplier. Water supply pressure to the seal water system may vary but shall be not less than 5 psi above pump sheet off pressure.

PART 3 – EXECUTION

3.1 INSPECTION. Examine bases and verify size of base and anchor bolt positioning. Rectify conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable for proper positioning, alignment and anchorage.

3.2 INSTALLATION. Each pumping unit shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards, and as required herein.

3.3 FIELD QUALITY CONTROL. The general requirements for system testing, check out, initial start-up, certification and instruction of plant personnel are contained in the section on Master Specification Section 01180, Equipment, Materials, Parts and Tools.

End of Section

SECTION 11700

SAMPLING PUMPS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous pumping units for pumping samples.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Each pumping unit shall be complete with a pump, constant speed electric motor, flexible coupling, coupling guard and all other appurtenances specified or otherwise required for proper operation. Each pumping unit shall be mounted on a common base.

Pumps of the close coupling type, having impellers attached directly to the motor shafts with no pump bearings or flexible couplings are not acceptable.

Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Contractor. Hydraulic considerations and definitions of terms shall be as set forth in the latest revision of the Hydraulic Institute Standards.

1.2.02 Governing Standards.

H.I.S. - Hydraulic Institute Standards

ANSI - American National Standards Institute

OSHA - Occupational Safety and Health Administration

ANSI - American National Standards Institute

ASTM - American Society for Testing and Materials

NEMA - National Electrical Manufacturing Association

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer's Field Services. Pump manufacturer shall provide services of factory-trained Service Engineer, specifically trained on type of equipment. Services include:

Align pump and motor couplings after pump bases have been grouted.

Shop and field test pumping units specified herein.

Provide a minimum of 2 man-days of on-site factory representative personnel to assist in the start-up and testing of pumping units. Man-day requirements do not include travel time and do not relieve the Contractor of his obligation to provide the required service to place all pump units in acceptable operation.

1.4 SUBMITTALS. Complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps
Name of manufacturer

Type and model

Rotative speed at rated condition

Materials of construction

Size of suction nozzle

Size of discharge nozzle

Net weight of pump only

Net weight with baseplate and coupling

Performance curves showing capacity versus head

Type of coupling

Submit product data on motors per Master Specification Section 16220, General Purpose Induction Motors-Procurement.

The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in Master Specification Section 01160, Training and Operations & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Shipping. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended. Deliver spare parts at same time as pertaining equipment. Deliver to Owner after completion of work.

1.5.02 Receiving. Store and safeguard equipment, material and spare parts, in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Pumps shall be as manufactured by Vaughn or approved equal.

2.2 SERVICE CONDITIONS. Each pump shall be furnished and installed in the area indicated. Each pump shall take suction from the sampling point indicated in the schedule and on the drawings and shall discharge continuous or intermittent samples to the sampling sink, sampler or other location as indicated on the drawings. Hose connections and valves will be provided in the suction and discharge piping from each pump as indicated on the drawings.

2.3 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each pumping unit shall be designed for the following operating conditions at maximum speed:

All pumps shall have 1-1/4 inch (3.2 cm) minimum size suction and discharge nozzles.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range.

2.4 PUMP CONSTRUCTION. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the amplitude of vibration as measured at any point on the machine shall not exceed 2 mils (0.05 mm).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

2.5 MOTORS. Motors shall be TEFC, solid shaft type per Master Specification Section 16220, General Purpose Induction Motors.

2.6 CONTROLS. Sample pump controls and motor starters shall be as shown on the Drawings and electrical schematics and shall be installed under requirements of Division 16 specifications.

PART 3 - EXECUTION

3.1 INSTALLATION. Each pumping unit shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards, and as required herein. Grouting shall be as specified in the grout section.

Each pump base shall be grouted after initial fitting and alignment but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3.2 SPARE PARTS. One mechanical seal for each pump shall be furnished. The spare parts shipment shall be properly identified on the outside of shipping boxes with purchase order number, name, and part number of parts enclosed specifically spelled out. Parts enclosed in boxes, crates, or packages shall be individually identified by name and manufacturer's part name.

End of Section

SECTION 11730

MIXERS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous mixing equipment and mixers for water and wastewater treatment processes.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Contractor.

Each unit shall be furnished and installed complete with all anchors and supports. Provide all mechanical equipment required for proper operation, including a complete drive unit and provide all additional materials or construction required by the manufacturer's design.

Power supply to the equipment will be 480 volts, 60 Hz, 3 phase, unless indicated otherwise on the drawings.

1.2.02 Governing Standards. Unless otherwise specified, the work of this Section shall conform to the applicable portions of the following Standard Specifications:

AFBMA – Anti-Friction Bearings Manufacturers Association

ANSI – American National Standards Institute

ASTM – American Society for Testing and Materials

NEMA – National Electrical Manufacturers' Association

1.3 QUALITY ASSURANCE. Mixing equipment shall be manufactured and assembled as specified herein and as indicated on the drawings. Mixing equipment shall be of same type from one manufacturer. Obtain drilling templates, space requirements and mounting instructions from mixer supplier.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly, foundation, and installation drawings, together with detailed specifications and data covering materials, power drive assemblies, and accessories forming a part of the equipment furnished, shall be submitted. Data and specifications for each unit shall include, but shall not be limited to, the following:

Number, size, and type of impellers.

Impeller shaft size, material, and number of sections.

Size, make, and type of electric motor.

Electrical control equipment.

Type, specifications, details, input and output speeds, exact gear ratios, and service factor (24 hour continuous service) of gear reducers.

Maximum horsepower requirements.

Ratio of rotative speed to critical speed of shaft.

Details of supporting base.

Submit product data on motors per Master Specification Section 16220, General Purpose Induction Motors-Procurement.

The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in Master Specification Section 01160, Training and Operations & Maintenance Manuals.

1.4.02 Certifications. Prior to start up the manufacturer shall provide written certification that the completed installation is in accordance with standards.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Shipping. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

Deliver spare parts at same time as pertaining equipment. Deliver to OWNER after completion of work.

1.5.02 Receiving. Store and safeguard equipment, material and spare parts in accordance with the manufacturer’s recommendation for protection from weather, temperature, and moisture contamination.

1.6 WARRANTY. The mixing equipment shall be warranted against defects in workmanship and materials for a period of 1-1/2 years from the date of final acceptance.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Drive units will be mounted outdoors and shall be suitable for outdoor operation with exposure to rain, snow, and dust. Submersible mixers shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65 feet (20 m).

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The impeller water-horsepower requirements, gear losses, and an ample allowance for buildup on the impeller for each mixer shall be included in determination of the brake horsepower requirements.

2.2.01 Dimensions. The mixers shall be designed for the requirements indicated on the drawings and for operation in tanks having dimensions indicated on the drawings.

2.3 ACCEPTABLE MANUFACTURERS. Mixing equipment shall be as manufactured by Chemineer, Mixing Equipment Company, Flygt Corporation, or Philadelphia Mixer Corporation.

2.4 MATERIALS. Fabricate mixing utilizing the following typical materials unless indicated otherwise:

Steel Plates and Shapes shall comply with ASTM A36.

Shafts shall comply with AISI Type 316 stainless steel.

Impeller Assemblies and Couplings shall comply with AISI Type 316 stainless steel.

All bolts, nuts, washers, and other fasteners that are submerged or subject to contact with the liquid shall be stainless steel. Bolting and fasteners not in contact with liquid shall be galvanized.

2.4.01 Elastomers. All mating surfaces where watertight sealing is required shall be machined and fitted with a double set of Nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O'rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

2.4.02 Bearings. All bearings shall have a minimum AFBMA L-10 rated life of 100,000 hours.

2.5 CONSTRUCTION.

2.5.01 General. All welded joints which will be fully or partially submerged shall be sealed watertight by continuous welds.

Sharp projections of cut or sheared edges of ferrous metals, other than stainless steel, which will be submerged in operation shall be ground to a radius as required to ensure satisfactory coating adherence.

All welds shall be thoroughly cleaned and ground smooth in preparation for coating. All ferrous metal surfaces, except stainless steel, shall be solvent cleaned in accordance with SSPC-SP1 before shop primer is applied.

2.5.02 Mixer Supports. Each mixer shall be designed and mounted so that it can be removed from its box as a complete unit after the impeller is removed from the shaft. Each mixer shall be assembled on a rigid and substantial base, and the base secured to the supporting structure. The opening in the mixer platform shall be large enough to permit removal of the shaft, including couplings, after removal of the impeller.

2.5.03 Impellers and Shafts. Each mixer shall be provided with a double turbine impeller of the open type without balancing rings or discs. Impellers shall be of a design, arrangement, and diameter and shall operate at a speed that will provide efficient and proper mixing as specified herein. The rotative speed shall be not more than 40 percent of the critical speed of the shaft (including impellers and appurtenances). Bottom steady bearings will not be acceptable.

The location of the impellers above the bottom of the tank shall be as recommended by the manufacturer and shall be acceptable to the Contracting Officer. Impellers shall be provided with split hubs or removable arms to permit the impellers to be removed in sections through the access hatches in the cover slab.

Vertical shafting for the impeller assembly shall be of ample size and design for the service intended and shall be supported and steadied so that the unit will operate without shaft whip or vibration.

Shafts shall be of the solid type, except that stainless steel sheathed shafts will be acceptable. Rigid type couplings shall also be fabricated from stainless steel. The gear reducer output shaft and the top half of the coupling need not be of stainless steel if a seal is provided around the shaft to prevent carbon slurry from reaching the coupling.

Shafts may be of the solid type or the torque tube type, as recommended by the manufacturer and accepted by the Engineer.

Each impeller shaft (exclusive of shafting in the gear reducer) shall be constructed preferably in one section, but in no case more than two sections, as determined by the manufacturer. If furnished in two sections, the shaft shall be connected with a suitable rigid coupling.

2.5.04 Shop Painting. All ferrous metal surfaces except stainless steel shall be given a shop coat of universal rust-inhibitive primer. The requirements for additional field coating are covered in the painting section.

2.6 MOTORS. Motors for the mixers shall be two speed, two-winding, variable torque type rated 460 volts, 60 Hz, 3 phase. Each motor shall be totally enclosed fan-cooled type. Refer to Master Specification Section 16220, General Purpose Induction Motors-Procurement.

2.7 DRIVE UNITS. Drive units shall be designed for the specific requirements of mixer service and shall be suitable for 24 hour a day operation under moderate shock conditions. Each drive unit shall consist of a foot-mounted electric motor and a gear reducer, with a flexible coupling provided between the motor and gear reducer. Drive units having a pinion mounted directly on the motor shaft will not be acceptable. Lifting lugs shall be provided on each motor and gear reducer. One set of lifting lugs shall be designed and located to permit lifting the complete mixer and drive unit. Motors shall be readily separated from gear reducers.

2.7.01 Gear Reducers. Supplementing the requirements of section on Equipment Materials, Parts and Tools, gear reducers shall be double or triple reduction type with helical or spiral bevel gearing. Worm gearing will not be acceptable. Output shaft shall be enclosed in a drywell which provides positive leakproof sealing. The mixer shaft shall be rigidly coupled to the output shaft.

All gear reducer and motor bearings shall be oil or grease lubricated, rolling element, antifriction type. Thrust bearings shall be provided to carry all shafting and impeller loads, plus an allowance of at least 25 percent of the weight of the shaft and impeller. No bearings shall be located below the bottom of the supporting platform.

Gear reducers shall be specifically designed for mixer service. The gear reducers shall be selected, designed, and rated in accordance with the appropriate AGMA standards. The gearing shall be designed with a life factor at least equivalent to 10 million cycles, and an overall service factor of 2.0, based on the sum of the continuous loads plus any transient loads other than starting loads. Bearings shall have an AFBMA L-10 Life Rating of at least 100,000 hours, except output shaft bearings, which shall have an AFBMA L-10 rating of at least 200,000 hours. The mixer manufacturer shall submit evidence of having furnished equipment similar in size, torque, and shaft overhang, which has performed successfully for a substantial period of time.

2.8 CONTROLS. Furnish controls as indicated on the drawings.

2.9 ACCESSORIES.

2.9.01 Baffles. Baffles, if required to prevent formation of vortices in the tanks, shall be furnished and installed with the mixers. Baffles shall be substantial, shall be of materials suitable for immersion and shall be acceptable to the Engineer.

PART 3 - EXECUTION

3.1 INSPECTION. Examine bases and verify size of base and anchor bolt positioning. Rectify conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable for proper positioning, alignment, and anchorage.

3.2 INSTALLATION.

3.2.01 General. Anchor bolts shall be supplied by the Equipment Manufacturer. Install equipment at locations and position as indicated on the plans with installation in strict conformance to manufacturer’s recommendations.

3.2.02 Hazardous Location Equipment. In addition to requirements listed above, for installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only mixers certified by Factory Mutual for use in such locations shall be used. Specifically, mixers used shall be certified for use in all Class I, Division 1 and 2, Groups C and D, and Class II, Division 1 and 2, Groups E, F, and G locations as outlined in Articles 500-502 inclusive of the NEC code.

In addition, the above mentioned certified mixers shall be installed in conjunction with mixer mounting hardware made of nonsparking materials.

3.2.03 In Basin Mixer Support. All mixers shall be supported in the basin as indicated on the Plans. The mixer mount assembly shall be provided by the mixer manufacturer for a complete system. The support structure shall be designed to withstand the thrust forces of the mixer when operating in water or out of water.

3.3 MIXER TEST. The mixer manufacturer shall perform the following inspections and tests on each mixer before shipment from the factory:

Propeller, motor rating, and electrical connections were checked for compliance to the purchase order.

All mixers are vacuum tested to establish sealing integrity. All mixers are momentarily energized to determine correct rotation and current draw.

All mixers are run to determine correct shaft rotation, thrust direction, and power consumption.

After immersion test(s), all mixers are inspected for oil seepage and/or water infiltration, insulation defect(s), and motor resistance (ohms).

Inspection and tests performed shall confirm the mixer(s) listed have met all established quality assurance standards set for similar materials. All mixers shall be warranted against defects in design, workmanship, and material (with validation being the warranty card(s) shipped with the product(s).

A written report stating the foregoing steps have been completed shall be furnished to the Engineer.

End of Section

SECTION 11740

CHEMICAL PUMPS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous chemical pumps for use in water and wastewater treatment applications.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Contractor. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

Each pumping unit shall be complete with a pump, electric motor, coupling guard, anchor bolts, and other appurtenances specified or otherwise required for proper operation, all mounted on a common baseplate. Pumps of the close-coupled type, with the impeller attached directly to the motor shaft without pump bearings or flexible couplings, will not be acceptable.

Master Specification Section 01180, Equipment, Materials, Parts and Tools shall apply to all equipment furnished under this section.

Power supply to equipment will be 480 volts, 60 Hz, 3 phase, unless indicated otherwise.

1.2.02 Governing Standards.

AFMB – Anti-Friction Bearings Manufacturers Association.

ANSI - American National Standards Institute.

ASTM - American Society for Testing and Materials.

H.I.S. - Hydraulic Institute Standards.

NEMA - National Electrical Manufacturing Association.

OSHA – Occupational Safety and Health Administration.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer's Field Services. Pump manufacturer shall provide services of factory-trained Service Engineer, specifically trained on type of equipment. Services include:

Furnish the pumps and motors, regardless of manufacturer, as a package to insure proper coordination and compatibility of equipment.

Assist during Installation in location of anchor bolts, setting, leveling, field erection, coordination of piping, electrical, and miscellaneous utility connections.

Align pump and motor coupling after pump base is grouted.

Start-up, testing, and calibration. Shop and field test pump units as specified herein.

Start-up and demonstrate each pump operation in cooperation with the variable frequency control supplier for pumping units with VFD units.

Provide operation and maintenance instruction.

Perform service inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls.

Provide 2 man-days minimum of service from factory representatives for each type of pump unit. Man-day requirements do not include travel time and do not relieve the Contractor of his obligation to provide the required service to place all pump units in acceptable operation.

1.3.02 Testing. Each pump casing shall be hydrostatically tested to 1.5 times maximum shut-off pressure by manufacturer. Each assembled pump shall be fully tested on water and have curves plotted to determine the rated capacity of each pump in accordance with the standard of HI USA.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished. The data for each unit shall include, but not be limited to, the following:

Pumps

Name of manufacturer

Type and model

Rotative speed

Size of suction nozzle

Size of discharge nozzle

Net weight of pump only

Net weight with baseplate and coupling

Complete performance curves showing capacity versus head, NPSH required, pump efficiency, and bhp

Type of coupling

Data on shop painting

Submit drawings and data for motors per Master Specification Section 16220, General Purpose Induction Motors-Procurement.

Submit operation and maintenance manuals in accordance with the procedures and requirements set forth in Master Specification Section 01160, Training and Operations & Maintenance Manuals.

1.4.02 Certifications. Submit certificate from manufacturer indicating that pumps have been properly installed, tested and are ready for operation.

1.4.03 Test Reports. Submit certified test of mechanically duplicate units.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Shipping. Ship equipment, materials and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

1.5.02 Handling Materials and Equipment. All material shall be handled in a manner as to eliminate the possibility of damage, breakage, or chipping in transit or otherwise.

1.5.03 Storage of Materials and Equipment. The Contractor shall store material and equipment in accordance with the manufacturer's recommendation for protection from weather, temperature, and moisture contamination.

1.6 WARRANTY. The pump manufacturer shall warrant the units being supplied to the Owner against defects in workmanship and material for a period of 1-1/2 years from the date of acceptance by Owner.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Pumping units shall convey measured quantities of chemical solutions to water or wastewater streams as indicated on the Drawings to enable chemical treatment processes to occur.

Chemical sump pumps shall be used to pump cleanup water and chemical solutions, including ferric chloride, liquid polymer, spilled carbon slurry and other chemicals used in water and wastewater treatment processes. Applicable pumps shall be capable of pumping the stored chemicals as follows.

Chemical	Max Concentration (% by Wt)	Max Specific Gravity	Max Temperature (Degrees F(C))	Max Viscosity (Centipoise)
Carbon Slurry	-	1.12	85 (29)	-
Ferric Chloride	47	1.53	85 (29)	-
Polymer	Varies	Varies	85 (29)	4000
Sodium Bisulfite	38	1.26	85 (29)	-
Alum	48.5	1.33	85 (29)	-
Sodium Hypochlorite	20	1.10	85 (29)	-
Sulfuric Acid	93	1.84	85 (29)	-
Hydrofluosilicic Acid	24	-	85 (29)	-
Chlorine	Varies	-	85 (29)	-
Sodium Hydroxide	50	1.54	85 (29)	-

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each pumping unit shall be designed for the general operating conditions shown on drawings and below:

Minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergence. The design performance shall be based on a wearing ring diametrical or axial clearance of not less than 1 mil per inch (2.54 cm) of wearing ring diameter, or 12 mils total, whichever is greater.

Pumping units shall be designed so that reverse rotation due to reverse flow will not cause damage to any component.

2.3 ACCEPTABLE MANUFACTURERS. Pumping units from the following manufacturers or on approved equal will be acceptable for use:

Eco Gearchem Pump, Rochester, N.Y.

Prominent Fluid Controls, Inc., Pittsburgh, PA.

2.4 MATERIALS. Provide chemical feed pumping units manufactured with materials indicated on the Drawings or as specified herein.

2.4.01 Chemical Sump Pumps. Pump Body and all wetted parts shall be molded of chemically inert Polypropylene (CPVC) (PVC).

Shaft shall be stainless steel sheathed with Kynar on wet end.

2.4.02 Transfer Pumping Units. Transfer pumps shall be seal-less magnetic drive centrifugal type. Pumps shall have one piece solid ductile iron casing. Impellers shall be one piece closed type. Shaft shall be one-piece, replaceable, non-rotating, and constructed of silicon carbide. The shaft shall be fully supported at both ends utilizing front shaft support and rear casing support, with an axial groove for improved lubrication and particulate bypass. The rear casing shall have a minimum 800 psi burst pressure. The magnetic coupling shall be designed for zero slippage and zero losses. All wetted parts shall be constructed of materials resistant to the pumped chemicals.

Pumps shall be Ansimag “Model KF”, or “K”, or “KM” or Iwaki Walchem “Model MDF” or equal.

2.5 PUMP CONSTRUCTION.

2.5.01 Casing Assembly. The casing assembly and drive connection shall permit the removal of the rotating element without disconnecting the piping. The discharge nozzle shall have a flanged cleanout handhole. Cleanout handholes shall have interior surfaces flush with the casing water passages. Casing parts shall have registered fit to maintain alignment. The nozzle flanges shall be flat faced, with ANSI/ASME B16.1, Class 125 diameter and drilling. A pipe-tapped opening shall be provided for draining stuffing box leakage.

Pipe-tapped openings shall be provided for draining, priming, and venting the casing.

2.5.02 Impeller. Shall be molded plastic with an investment casting insert, statically balanced, and keyed on the shaft. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be securely locked to the shaft so that it will not be loosened by reverse rotation, but shall be easily removable.

The impeller shall be semi-open nonclog type, with at least 3 ports, and shall be locked to the shaft with a self-locking or pinned nonclog type fastener.

2.5.03 Shaft and Shaft Sleeves. The shaft shall be completely machined. Deflection at the stuffing box shall not exceed 0.002 inch (.05 mm) at any head in the operating range. A suitable splash deflector shall be mounted on the shaft adjacent to the frame bearing housing.

The shaft shall be provided with a replaceable sleeve extending from the impeller through the stuffing box. The sleeve shall be positively secured to the shaft and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch (.05 mm).

The stuffing box for each pumping unit shall contain a double mechanical seal. Each mechanical seal shall be provided with a flushing water connection.

2.5.04 Frame Assembly. The frame assembly shall rigidly support the rotating element with two bearings. The outboard bearing shall carry both axial and radial pump loads. The assembly design shall permit axial adjustment of the rotor without dismantling the pump. Bearing enclosures shall keep out contaminants and retain the lubricant and shall have adequate provisions for adding and draining lubricant.

The frame shall provide ample clearance for stuffing box maintenance.

Bearings shall be either oil or grease lubricated, antifriction type. Bearings shall have an AFBMA L-10 Life Rating of 100,000 hours at specified operating conditions. The pump shaft speed shall not exceed the limits specified by the bearing manufacturer.

2.5.05 Flexible Coupling. The pump coupling shall have a horsepower rating 1.25 times the motor nameplate horsepower when the misalignment is within the manufacturer's tolerance limit. Coupling design shall permit removal of the pump rotating element without disconnecting the piping, moving the drive unit, or axial movement of the coupling halves on the shaft.

2.5.06 Anchor Bolts. Shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2-1/2 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with thickness of approximately 1/2 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto.

2.5.07 Baseplates. Shall be provided with adequate openings for grouting and venting. Baseplates shall provide for tapered dowels to maintain alignment of pump and motor.

2.6 MOTORS. Each pump shall be supplied with an electric motor. Each motor shall be squirrel-cage induction type, horizontal, open-drip proof, premium efficient, and rated 460 volts, 3 phase, 60 Hz, and shall conform to Master Specification Section 16220, General Purpose Induction Motors-Procurement.

If the motor is not shop tested with the pump, certified motor efficiency data shall be furnished to the pump supplier based on tests conducted on the motor or on an identical motor.

Provide a fused power factor correction capacitor for each motor, sized to improve motor power factor to 0.95 (lagging) when operated at full load.

2.7 CONTROLS. Chemical feed and transfer pumps' controls shall be as shown on the P&IDs and electrical schematics and shall be installed under Master Specifications Division 17.

2.8 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational dynamic balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed 4 mils.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

2.9 SHOP TESTING. Factory test operation of each type of pumping unit. Provide certified test reports in accordance with the latest edition of the Hydraulic Institute Standards.

2.10 ACCESSORIES. Each pump shall be provided with lifting eyebolts or lugs; plugged gauge cock connections at the suction and discharge nozzles; tapped and plugged openings for casing assembly and bearing housing vents and drains; and appropriate fittings for adding bearing lubricant and seal water. Grease lubricated pumping units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

PART 3 - EXECUTION

3.1 INSTALLATION. Each pumping unit shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. Installation procedures shall be as recommended by the pump manufacturer and the Hydraulic Institute Standards, and as required herein. Grouting shall be as specified in the grout section.

The pump base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, pump connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

Shimming between machined surfaces will not be permitted.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. The general requirements for system testing, check out, initial start-up, certification and instruction of plant personnel are contained in the section on Equipment, Materials, Parts and Tools. After initial start-up, a preliminary running-in period will be provided for the Contractor to make field tests and necessary adjustments. Under the supervision of a qualified representative of the pump manufacturer. The Contractor will then operate the pumps for a period of 30 consecutive calendar days.

At the end of the specified period of operation, the pumping unit will be accepted if, in the opinion of the Engineer, it has operated satisfactorily, without excessive power use, wear, or need for lubrication, or requiring undue attention; and if all its rotating parts operate without excessive vibration or noise at any operating head, including shutoff.

3.3 SPARE PARTS. The following spare parts shall be furnished:

1 set of pump bearings.

1 set of wearing rings or wear plate.

1 set of 0-rings.

1 set of seals.

1 Impeller per pump.

Spare parts shall be suitably packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools with labels indicating the contents of each package. Spare parts shall be delivered to the Owner as directed.

End of Section

SECTION 11745

CHEMICAL FEED SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers liquid chemical feed systems, equipment, and accessories for water and wastewater treatment processes. Principal items to be furnished and installed include the following:

1.1.01 Coagulant (Alum) Feed System.

Day tanks
Metering pumps
Calibration columns

1.1.02 Fluoride (Hydrofluosilicic Acid) Feed System.

Transfer pumps
Day tanks
Metering pumps
Diffusers
Calibration columns

1.1.03 Activated Carbon Feed System.

Dust removal unit
Day Tanks
Metering pumps
Diffusers
Calibration column

1.1.04 Coagulant Aid (Polymer) Feed System.

Recirculation/mixing pumps
Polymer blenders (including transfer pumps)
Aging tanks
Polymer system control panel
Metering pumps
Calibration columns
Secondary dilution water panel
Static mixers
Diffusers

1.1.05 Sulfuric Acid Feed System.

Transfer pumps
Day Tanks
Metering pumps
Calibration columns

1.1.06 Caustic Soda Feed System.

Day tanks
Metering pumps
Calibration column

1.1.07 Sodium Bisulfite Feed System.

Day Tanks
Metering pumps
Calibration column
Diffusers
Rotameters

1.1.08 Filter Aid (Polymer) Feed System.

Polymer makedown units
Transfer/recycle pumps
Day tanks
Booster pumps
Calibration column
Diffusers

1.1.09 Phosphoric Acid (Corrosion Inhibitor) Feed System.

Day tanks
Metering pumps
Calibration column
Diffusers

1.1.10 Chlorine Feed System.

Container scales for chlorine ton containers.

Ton container hook-up assemblies.
Automatic switchover systems.
Evaporators.
Vacuum regulators.

Chlorine feeders.
Chlorine solution injectors
Diffusers.

1.1.11 Sodium Hypochlorite Feed System.

Metering Pumps.

The following items of work and equipment are covered under other sections:

Bulk chemical storage tanks.
Carbon Slurry mixers and transfer pumps.
Hoist and monorail for chlorine ton containers.
Piping and valves between items of equipment.
Instrumentation.
Water supply and electric power supply to the equipment.
Drain and vent piping

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

1.2.01 General Equipment Stipulations. Each item shall be furnished and installed complete with all mechanical and electrical equipment required for proper operation. Furnish all components indicated on the drawings or specified, and all additional materials or construction required by the design of the system.

Master Specification Section 1018, Equipment, Materials, Parts and Tools shall apply to all equipment furnished under this section.

All electrical equipment shall conform to applicable standards of Master Specifications Division 16, Electrical.

Unless otherwise specified, the power supply will be 120 volts, 60 Hz, single phase. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished.

Metal thickness and gages specified herein are the minimum required. Gages refer to US Standard gage.

A nameplate shall be provided and mounted on or adjacent to each chemical feeder to identify its function. Nameplates shall be approximately 1 by 3 inches (2.54 and 6.62 cm), made from stainless steel material. Letters shall be engraved. Feeder designations on the nameplates shall correspond to those indicated on the drawings.

Similar components of different chemical feed systems shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

1.2.02 Governing Standards.

H.I.S. – Hydraulic Institute Standards

ANSI – American National Standards Institute

OSHA – Occupational Safety and Health Administration

ASTM – American Society for Testing and Materials

NEMA – National Electrical Manufacturing Association

1.3 QUALITY ASSURANCE. Provide 2 man-days minimum of service from factory representatives for each type of Chemical Feed System, on two separate visits Man-day requirements do not include travel time and do not relieve the Contractor of his obligation to provide the required service to place all units in acceptable operation.

Provide services of factory-trained Service Engineer, specifically trained on type of equipment. Services to include:

Assist during installation with location of anchor bolts, setting, leveling, field erection, coordination of piping, electrical, and miscellaneous utility connections.

Perform start-up, testing, and calibration.

Conduct service inspections during first year of operation, for use at Owner's request, and exclusive of repair, malfunction or other trouble-shooting service calls.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete fabrication, assembly, and installation drawings, isometric piping schematics, and wiring diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be.

1.4.02 Certifications. The Supplier shall submit proof of the following qualifications:

The supplier has the required financial capability.

The names of manufacturers whose products will be supplied.

The supplier maintains a qualified technical staff and design office.

The supplier has the physical plant and fabricating personnel to complete the work specified.

The suppliers have and will maintain competent service personnel to service the equipment furnished.

The supplier has successfully provided similar work for at least 5 years.

The names of at least three references that are users of similar systems designed, assembled, and furnished by the supplier.

1.4.03 Test Reports. The supplier shall prepare a calibration graph from field tests for each chemical feed unit which does not have a rate set device reading in pounds per hour for dry feeders or in gallons per hour for liquid feeders. The graph shall show the rate setter graduation conversion to pounds per hour or gallons per hour throughout the range of the feed unit. Each graph shall be furnished on hard paper and sealed in clear plastic.

The Supplier shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in Master Specification Section 01160, Training and Operations & Maintenance Manuals.

Refer to Master Specifications Section 01080, Project Submittals for additional requirements.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Shipping. Ship equipment, materials, and spare parts complete, except where partial disassembly is required by transportation regulations or for protection of components.

Pumps and accessories shall be prepared for shipment after testing. Preservative shall be applied to machined surfaces and journals to prevent corrosion during transit.

Pack spare parts in containers for long-term storage bearing labels clearly designating contents and pieces of equipment for which intended.

Deliver spare parts at same time as pertaining materials in the containers for long-term storage. The Contractor shall furnish and deliver to the Engineer 1 complete set of special tools and wrenches required.

1.5.02 Receiving and Storage. Inspect and inventory items upon delivery to site. Store all equipment as directed by the Engineer.

1.6 SYSTEM SUPPLIER. Each chemical feed system shall be designed, coordinated, and supplied by a qualified system supplier who is regularly engaged in the business of designing and assembling liquid chemical feed systems for water and wastewater projects.

The suppliers shall prepare system installation drawings, isometric piping schematics, interconnecting diagrams, panel layouts, and other data required for complete system description. The supplier shall verify that each system component is compatible with all other components of the system, that all pipe materials and sizes are appropriate, and that all devices necessary for a properly functioning system have been provided.

Review of drawings submitted prior to the final determination and coordination of related equipment to be provided will not relieve the Supplier from responsibility for supplying systems in full compliance with the specific requirements of the related equipment.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Chemical feed equipment shall be of substantial construction with all parts designed for long life under working conditions including corrosive atmospheres and intermittent or continuous operation. All wearing parts and items requiring adjustment shall be readily accessible. Each unit shall be completely enclosed and dust tight when in operation. All parts which are exposed to corrosive conditions shall be made from corrosion-resistant materials or covered with suitable protective coatings. All electrical enclosures shall be NEMA 4X fiberglass reinforced plastic.

Chemical piping connections with valves, pumps, and other equipment shall be flanged. No threaded connections are allowed.

Each chemical feed system, except for the day tanks, shall be completely assembled, mounted and delivered to the site on a single skid. Components to be mounted on each skid shall include, but not be limited to the metering pumps, instrumentation, calibration column, all piping, valves, and piping accessories from the isolation valve immediately upstream of the calibration column up to and including the back pressure valve. The chemical feed system supplier shall be responsible for providing all equipment, valves and piping within the skid.

2.2 ELECTRICAL. All Electrical requirements shall conform to Master Specification Section 16220, General Purpose Induction Motors-Procurement which includes but is not limited to equipment, controls and motors. All motors shall be suitable for corrosive duty service.

Each metering pump shall be equipped with a dc motor for operation from a rectified 60 Hz, single phase power supply.

2.3 COAGULANT (ALUM) FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed, as indicated on the drawings, to dispense one of four coagulant chemicalsMaterials of construction of all components in contact with the coagulant shall be suitable for all four potential coagulants. The chemical shall be one of the following:

48.5 percent alum with a specific gravity of 1.33

47 percent ferric chloride with a specific gravity of 1.53

43 percent ferric sulfate with a specific gravity of 1.56

51 percent polyaluminum chloride with a specific gravity of 1.34

2.3.01 Day Tanks. Each day tank shall have a useful capacity needed for operation not to be less than 24 hours of operation. All parts of the tank shall be fabricated of translucent fiberglass reinforced vinyl ester plastic material of sufficient weight for adequate support and protection. The tank shall be flat bottom, flanged top type, conforming to dimensions indicated on the drawings, as manufactured by Raven Industries, Inc. The tank shall include bonded flanged fittings for inlet, overflow, and gauge glass. Hold down lugs shall be provided to anchor the tank to the base.

A gasketed cover shall be provided with a Type 316 stainless steel or chemical-resistant plastic piano type hinged access door for inspection and cleaning of the tank and with flanged connections described above.

A chemical-resistant valve and gauge glass assembly shall be mounted on the side of the tank. Steel protection rods shall be provided the full length of the gauge. Valve assemblies shall be Type 316 stainless steel with integral ball checks to prevent flow in the event of gauge glass failure.

The supplier shall coordinate with the Contractor to incorporate instrument flanged connections on the day tanks for level measuring instruments. Level measuring instruments will be supplied by others.

2.3.02 Metering Pumps. Metering pumps shall be furnished and installed as indicated on the drawings to dispense any of the four coagulants to the point of application.

Each pump shall include continuous local manual/remote manual and remote auto controlled metering of solution under the following conditions and requirements. Refer to Master Specification Division 17, Instrumentation and Controls for additional information.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished. Motor shall be not less than the indicated horsepower.

Each pump shall be of the positive displacement type, using a hydraulic plunger actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housing. Diaphragms relying solely on friction and compression of the diaphragm material for installation and leak prevention will not be acceptable.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

Inlet and outlet check valves shall be of the single valve type, with valve housing which is removable without disassembly of threaded pipe fittings.

Materials of construction shall be selected for resistance to the pumped solutions.

Each pump shall be mounted on a structural steel or cast iron base to be set on the equipment skid as indicated on the drawings and shall include a self-lubricating speed reducer and liquid end splash guards.

Each pump shall be furnished with the following accessories:

One back pressure valve, factory adjusted for the back pressure recommended for the pump.

One internal pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacture.

One vent valve.

One properly sized diaphragm type surge chamber in each pump discharge piping arrangement. Each chamber shall be fabricated of materials resistant to the pumped solutions, and shall include an air charging valve and air gauge. The chamber shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

One strainer installed in the inlet piping. The strainer shall be PVC bodied Y-pattern, with 8 mesh screen and O-ring seals.

All wiring shall be furnished complete and ready for connection to an external power circuit.

The metering pumps shall be Wallace and Tiernan “Chemtube 2000”, Milton Roy "Milroyal B" or Pulsafeeder "Series 7440".

2.3.03 Calibration Columns. Transparent plastic calibrating columns shall be furnished and installed on the pump suction piping as indicated on the drawings.

The columns shall be 6 inch (15.24 cm) ID clear PVC or other resistant, rigid, transparent plastic tubing complete with vented top cap and 1 inch (2.54 cm) screwed flow fitting. The column shall be graduated in 0.1 gallon (.378 L) increments over a range of 0 to 1.8 gallons (0 to 6.813 L), complete with a numeral at each graduation. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs.

2.4 FLUORIDE (HYDROFLUOSILICIC ACID) FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed, as indicated on the drawings, to dispense 24 percent hydrofluosilicic acid solution to the points of application.

2.4.01 Transfer Pumps. Transfer pumps shall be furnished and installed as indicated on the drawings. Each pump shall be designed for pumping hydrofluosilicic acid from storage tanks to day tanks.

Each pumping unit shall be of the positive displacement peristaltic type utilizing a flexible hose and shoe. Pumps shall be Alfa Laval “Model IP800” or Watson Marlow/Bredel “Model SP/65”, and shall be designed for the following conditions.

Each pump shall consist of a sealed lubricant filled housing, pump hose, rotor assembly, and one-piece connectors. The process fluid shall only be in contact with the inside of the pump hose.

The pump hose shall be a three-layer reinforced hose consisting of a natural rubber outer layer, nylon braided reinforcing layer and an inner wetted layer of natural rubber. The hose shall be of 53-68 durometer with a static burst pressure of 600 psi (4,136 kPa). The hose shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge sides by a one piece cast neoprene seal gland. Hose type clamp fittings are not acceptable. The hose shall be replaceable without removing the pump or opening the pumphead door. Inlet/outlet connectors shall be one solid piece and shall be located by and secured to the pump housing by permanent 316 stainless steel studs and hex nuts.

The rotor assembly shall be equipped with two polished aluminum sliding shoes. Shoes shall be located 180 degrees apart for compression of the hose against the track twice per rotor revolution. Each rotor assembly shall be keyed to the output shaft of the gear reducer/gearmotor and be axially secured to that shaft by a heavy-duty washer and socket head cap screw. Each rotor assembly shall have ribbed spokes, which will create constant circulation of lubricant upon rotation to enhance lubrication and cooling within the pump housing.

Each pump shall be supplied with an integral squirrel cage induction type gear motor rated 460 volts ac, 3 phase, 60 Hz. The motor shall have a fan sized for adequate cooling of the drive at the lowest operating speed. Gearing shall be of the helical gear arrangement, classified for continuous heavy shock, AGMA Class II, 24-hour duty. Minimum gear reducer efficiency shall be 95 percent. The motor shall be contained in a cast iron housing suitable for corrosive duty. Refer to Master Specification Section 16220, General Purpose Induction Motors for complete details.

Each pump shall be completely self-priming with a suction lift capability of up to 20 feet (6 m). The pump shall be capable of running dry without damaging effects to the pump or hose. The pump shall be valveless and without diaphragms and not utilize any dynamic seals.

The pump housing shall contain a threaded drain plug and vent port. The drain shall be located at the lowest point in the housing and allow for complete removal of all liquid from within the housing.

Three complete sets of spare parts, as recommended by pump manufacturer, shall be provided.

Each pair of transfer pumps shall be furnished with a control panel incorporating magnetic-only adjustable circuit breaker type disconnects and NEMA rated motor starters (per Master Specification Section 16480, 600 Volt Class Motor Control Centers and Division 16, Electrical) with thermal overload protection. The local control panel shall be wired to shut down the pump and alarm on pump high discharge pressure and can be restarted only if the alarm is reset at the local control panel. The pump will also be wired to stop and alarm on high “Day Tank Level” and Low “Bulk Tank Level”. These alarms will reset when the condition does not exist.

The local control panel shall include as a minimum the following:

Power ON/OFF selector switch.

L/O/R selector switch.

Start and Stop push buttons.

“Running”, “Off”, “ Day tank high level Alarm”, “ Bulk tank low level Alarm”, “ High discharge pressure Alarm”, and “Power on” lights.

RESET push button.

Normally closed contacts pre-wired to terminals for external connection by others corresponding to:

“Pump Failure”

“Pump Running”

“L/O/R” switch position

Discharge pressure high shall be able to accept:

Digital inputs to Start and Stop the Pump

Digital inputs from Day Tank high level switch, Pump discharge pressure switch, and Bulk Tank low level switch.

All pilot devices shall be transformer type, 30 mm, oil tight type. Relays shall be 3PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings.

2.4.02 Day Tanks. Each day tank shall have a useful capacity for not less than 24 hours for the process intended and shall be provided with a scale graduated in gallons. All parts of the tank shall be fabricated of translucent polyethylene plastic material of sufficient weight for adequate support and protection. Each tank shall be flat bottom, dome top type, as manufactured by Raven Industries, Inc. or equal. Each tank shall include flanged fittings for inlet, overflow, pump suction, and gauge glass. Hold-down lugs shall be provided to anchor the tank to the base.
A gasketed cover shall be provided with an 18 inch (45.7 cm) diameter bolted and gasketed access hatch for inspection and cleaning of the tank

The supplier shall coordinate with the Contractor to incorporate instrument flanged connections on the day tanks for level measuring instruments. Level measuring instruments will be supplied by others.

2.4.03 Metering Pumps. Metering pumps shall be furnished and installed as indicated on the drawings to dispense hydrofluosilicic acid or other solution to the points of application. The materials used shall be able to handle the various solutions to be used in the processes.

Each pump shall include continuous remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished.

Each pump shall be of the positive displacement type, using a hydraulic plunger actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housing. Diaphragms relying solely on friction and compression of the diaphragm material for installation and leak prevention will not be acceptable.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable heads.

Inlet and outlet check valves shall be of the single valve type, with valve housing which are removable without disassembly of threaded pipe fittings.

Materials of construction shall be selected for resistance to the pumped solution.

Refer to the sections on Pump Controls and Instrumentation for more details.

Each pump shall be mounted on a structural steel or cast iron base to be set on the equipment skid as shown on the Drawings and shall include a self-lubricating speed reducer and liquid end splash guards.

Each pump shall be furnished with the following accessories:

One back pressure valve, factory adjusted for the back pressure recommended for the pump.

One internal pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacture.

One vent valve.

One properly sized diaphragm type surge chamber in each pump discharge piping arrangement. Each chamber shall be fabricated of materials resistant to the pumped solution, and shall include an air charging valve and air gauge. The chamber shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

One strainer installed in the inlet piping. The strainer shall be PVC bodied Y-pattern, with #8 mesh screen and O-ring seals.

All wiring shall be furnished complete and ready for connection of an external power circuit per Master Specification Division 16, Electrical.

The metering pumps shall be Wallace and Tiernan “Chemtube 200” or “2000”, Milton Roy "Milroyal B", or Pulsafeeder "Series Pulsar 25HJ and 7440" or equal.

2.4.04 Diffusers. Two channel type diffusers, one corporation cock type diffuser and one special type as detailed on the drawings, shall be provided. The diffuser tube shall be fabricated of PVC.

2.4.05 Calibration Columns. Transparent plastic calibrating columns shall be furnished and installed on the pump suction piping. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs.

2.5 ACTIVATED CARBON FEED SYSTEM. One assembly of preparation and feeding equipment shall be furnished and installed to prepare and dispense carbon slurry.

2.5.01 Dust Removal Unit. Ejector-venturi gas scrubbers and dust removal units with separator, shall be furnished and installed on the carbon slurry storage tanks. The scrubber shall be used to remove powdered activated carbon dust from the air exhausted from the tanks during the pneumatic unloading of carbon into the tanks. The scrubber shall be designed for intermittent operation. The scrubber and separator shall be constructed from fiberglass-reinforced plastic. Water from the separator shall drain into the carbon storage tank. The clean air outlet from the separator shall be covered with a stainless steel insect screen and shall discharge to the atmosphere. The scrubber/separator shall be provided by Ametek “Type 7014 Scrubber-Separator System or equal.

2.5.02 Metering Pumps. Metering pumps furnished shall be sizedto pump water slurry solution to points of application as required. Each pumping unit shall be of the positive displacement peristaltic type utilizing a flexible hose and shoe. Pumps shall be Alfa Laval “Model IP600” or Watson Marlow/Bredel “Model SP/50”, or equal.

Each pump shall be supplied with an integral squirrel cage induction type gear motor rated 460 volts ac, 3 phase, 60 HZ per Section 16220 of Electrical Division 16. The motor shall have a fan sized for adequate cooling of the drive at the lowest operating speed. Gearing shall be of the helical gear arrangement, classified for continuous heavy shock duty, AGMA Class II, 24-hour duty. Minimum gear reducer efficiency shall be 95 percent. The motor shall be contained in a cast iron housing suitable for corrosive duty.

Each motor shall be specifically selected for service with an adjustable frequency type speed controller and shall compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. This is to ensure the motor does not exceed Class B temperature rise when operating in the installed condition at load. All motors shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG1, Part 31.

Each motor shall be furnished with an adjustable frequency drive conforming to the requirements of Master Specification Section 16150, Variable Frequency Drives . Each adjustable frequency drive shall be capable of varying the speed of the pump to deliver the metering range as specified. The drive shall be powered from a 480 volt, 3 phase, 60 Hz power supply. The drive shall be provided in the local panel supplied by the vendor. The drives shall be provided by the pump manufacturer to ensure a coordinated system.

Two complete sets of spare parts as recommended by pump manufacturer shall be provided.

Each pump shall be provided with a local panel with the following minimum components/output and control:

Shall be able to accept a remote 4- 20mA signal to control the rate of feed by varying the speed of the pump.

Shall be able to provide a 4-20mA signal for remote indication.

Shall be able to accept 2 remote digital inputs to start and stop the pump.

Shall provide contact for remote signaling of “Remote” status.

“Running” and “Fail” status.

Shall provide volt free contacts for pump discharge pressure high and discharge low flow.

Shall have “Local/Off/Remote” selector switch.

Shall have power “On/Off” selector switch.

Shall have local indicating lights for “Running”, “Off” and “Power on” status.

Shall have local speed adjustment.

Shall have Alarm lights for High Discharge Pressure and Low Discharge Flow.

Shall have push buttons for Start, Stop and Reset.

All pilot devices shall be transformer type, 1- 1/6 inch (30 mm), and oil tight type. Relays shall be 3PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings.

Each pump shall be Hardwire interlocked, such that the pump will stop:

On High Discharge Pressure

Low Discharge Flow

Low Bulk Tank Level

In local mode the pump shall be started and stopped from the LCP and speed can be adjusted locally, with no control possible from a remote control system. In remote mode, all control is transferred to a remote control system.

2.5.03 <u>Diffusers</u>. Two channel type diffusers shall be provided. The diffuser tubes shall be fabricated from stainless steel.

2.5.04 <u>Calibration Columns</u>. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping.

The column shall be 12 inch (30.5 cm) ID clear PVC or other resistant, rigid, transparent plastic tubing complete with vented top cap and 1 inch (2.54 cm) screwed flow fitting. The column shall be graduated in 0.25 gallon (1 L) increments over a range of 0 to 18 gallons (0 to 68 L), complete with a numeral at each graduation. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs. The column shall have a water connection.

2.6 COAGULANT AID (POLYMER) FEED SYSTEM. One complete polymer feed system consisting of solution preparation equipment and feed equipment shall be furnished and installed as indicated on the drawings. The entire polymer feed system shall be furnished and integrated by Stranco, Inc. or Fluid Dynamics or equal. The system shall prepare polymer solution from liquid emulsion polymer delivered in bulk. The system shall transfer, wet, mix, and age the polymer for feeding to the polymer diffuser. The system shall automatically prepare aged polymer solution of a selected strength in aging tanks to provide a continuous supply of polymer solution to the polymer metering pumps. The system shall also be capable of complete manual batching operation. The polymer feed batching operation shall be operated and controlled as desired from a polymer feed system control panel.

2.6.01 Recirculation/Mixing Pumps. Recirculation/mixing pumps shall be furnished to recirculate neat polymer.

The pumps shall operate under the following conditions and requirements:
The pump shall be of the progressing cavity type, constructed of materials selected for resistance to the pumped solution, at least Type 316 stainless steel and EPDM synthetic rubber. The pump shall be heavy-duty, universal pin joint type. The pump and drive shall be mounted on a structural steel baseplate complete with a drip rim, a drainage connection, and suitable guards.

The pump shall have a stable head-capacity curve and be free from cavitation and objectionable noise. Pumping heads and other terms shall be as defined in the Hydraulic Institute Standards.

The pump shall be provided with a high discharge pressure switch and a pressure switch isolator, to stop the pump on excessive discharge pressure.

Suction and discharge nozzles shall have ANSI Class 125 pound flanges and shall be tapped and plugged for a pressure gauge connection. The pump stuffing box shall be tapped at the lantern ring position for an outside water seal connection. The pump shall be furnished with Durametallic “Type RO” mechanical seals, and shall be arranged for side suction and end discharge.

The pump shall be Netzsch, Nemo Pump Division, Robbins & Myers, Moyno, Seepex “Group N”, or equal.

The local control panel shall include as a minimum the following:

Power ON/OFF selector switch

L/O/R selector switch

Start and Stop push buttons

“Running”, “Off”, “Discharge Pressure High Alarm”, “Seal Water Pressure Low”, Low Discharge Flow, and “Power On” lights

RESET push button

Normally closed contacts pre-wired to terminals for external connection by others corresponding to:

“Pump Failure”

“Pump Running”

“L/O/R” switch position

Discharge Pressure High

Seal Water Pressure Low

Low Discharge Flow

Shall be able to accept:

Digital inputs to Start and Stop the Pump

Digital inputs from, Pump discharge pressure switch, Seal water pressure switch, Low discharge flow switch and Bulk Tank low level switch.

2.6.02 Polymer Blenders. Polymer blending units shall be provided for wetting and blending liquid polymers with the tempered service water supply. The blenders shall receive and blend liquid polymers with water and completely wet the liquid polymer particles. The polymer mixing device shall impart the necessary initial mixing energy for efficient polymer activation to prevent the formation of fisheyes, stringers, and excessive mixing times and excessive polymer use.

Water control components and piping shall include pressure switches, automatic valves, flowmeters, and flow control valves to provide control of water flowrates as required through the blender for wetting of the polymer and transfer of solution to the aging tanks. The pressure switches and controls shall not allow the system to operate with inadequate water supply pressure.

A strainer, pressure gauges, pressure regulating valve, isolation valves, and temperature gauge shall be provided on the primary dilution water supply to the blender in addition to those furnished with the blender package.

Water in excess of that required by the blender may bypass the blender for filling the aging tanks. Appropriate piping, valves, and controls shall be furnished as required for a complete system.

Each unit shall have a neat polymer transfer pump. The pumps shall be positive displacement, progressing cavity type, having materials of construction selected for resistance to the pumped solution, at least Type 316 stainless steel and synthetic rubber. Each pump shall be a heavy-duty universal pin joint type.

A totally enclosed motor directly connected to a gear reducer shall drive each pump per Master Specification Section 16220, General Purpose Induction Motors-Procurement. Maximum motor speed shall not exceed 1,800 rpm.

Each transfer pump shall be furnished with a control panel incorporating magnetic only adjustable circuit breaker type disconnect and NEMA rated motor starters with thermal overload protection. All pilot devices shall be transformer type, 1-1/6 inch (30 mm), and oil tight type. Relays shall be 3PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings. The local control panel shall be pre-wired that the pump will shut down and alarm on pump high discharge pressure, low discharge flow, low seal water pressure and can be re-started only if the alarm is reset at the local panel. The pump will also be wired to stop and alarm on high “Aging Tank Level” and Low “Bulk Tank Level”. These alarms will reset when the condition does not exist. All electrical shall be in compliance with Master Specification Division 16, Electrical.

The local control panel shall include as a minimum the same features as that for the recirculation/mixing pumps and shall be able to accept:

> Digital inputs to Start and Stop the Pump.
>
> Digital inputs from Pump discharge pressure switch, Seal water pressure switch, Low discharge flow switch, Aging Tank low level, Aging Tank high level, and Bulk Tank low level switch.

2.6.03 Aging Tanks. Each aging tank shall have a useful capacity as required for the process. All parts of each tank shall be fabricated from translucent fiberglass reinforced vinyl ester plastic or Type 304 stainless steel material of sufficient weight for adequate support and protection. Each tank shall be of the flat bottom, open flanged top type of cylindrical or square configuration. Each tank shall include flanged fittings for inlet, side bottom outlet, gauge glass, and overflow. Bonded flanged fittings shall be provided with FRP tanks. Hold-down lugs and anchor bolts shall be provided to anchor each tank to the base.

The supplier shall coordinate with the Contractor to incorporate instrument flanged connections on the aging tanks for level measuring instruments. Level instrument will be supplied by others. Operation and control of the system is covered in the Polymer System Controls paragraph. Each tank shall have a cover equipped with a split access door with piano-type hinges for inspection and cleaning of the tank, and openings for electrodes and connection of piping. The hinge shall be fabricated of Type 316 stainless steel or chemical-resistant plastic. The door shall be so oriented that the opening is accessible from the platform.

A chemical-resistant valve and gauge glass assembly shall be mounted on each tank. The gauge glass shall be fabricated of 1 inch (2.54 cm) thick clear Schedule 40 PVC, and shall be graduated over a 0 to 3,000 gallon range in 50 gallon increments, with a numeral at each 100 gallon graduation. Valve assemblies shall be Type 316 stainless steel with integral ball checks to prevent flow in the event of gauge glass failure.

2.6.04 Polymer System Control Panel. The electric primary dilution water supply valve, polymer blender drive, polymer transfer pump, electric transfer valves, and accessories previously specified shall be controlled from the system control panel and shall operate as an automatic polymer solution preparation system. Controls shall also be furnished for complete manual preparation of polymer solution. The system shall be installed and wired complete, ready for connection of a 480 volt, 3 phase power supply and plant control system outputs. System wiring shall be in conduit. Cable and conduit shall meet the requirements specified in the electrical section. The polymer system controls and control panel shall be furnished by the polymer system manufacturer.

The control panel shall be the polymer system manufacturer's standard oil and dust tight enclosure for polymer control service. Terminal blocks shall be provided for connection of all external wiring to the panels. This shall include power supply complete with circuit breaker type disconnect and remote equipment controls as required by the equipment furnished.

All instrument and component device wiring shall be furnished as described below. All wiring shall be grouped or cabled and firmly attached to the panel. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings.

All instruments and devices shall be separately fused as required to protect the equipment. All devices within the panels shall be permanently identified. The device and terminal designations shall agree with those indicated on the equipment drawings.

Push-button control and selector switches to be mounted on the front of the control panel shall be full size 30 mm, oil tight, heavy-duty type with the control function engraved on the lens cap.

Each switch shall have a nameplate indicating the controlled unit. Indicating lights shall be full size 30 mm heavy duty, push-to-test transformer type. Lenses shall be amber for alarm indication, red for run indication, and green for off indication.

Auxiliary relays and timers shall have 120 volt, 60 Hz continuous duty coils and 10 ampere, 3PDT, 120 volt ac contacts.

The polymer control panel shall transmit the following alarm signals to a control and status system in addition to the signals stated for the transfer pumps. Digital interface signals shall be 120 volt ac dry contacts rated for at least 5 amperes.

Polymer System Master Alarm.

Water Supply Low Pressure Alarm.

Low Level Cutoff on the selected aging tank for metering pump cutoff.

Major components to be installed on the front of the control panel shall include, but not be limited to, the following items:

System " Local, Off, Remote" selector switch.

Polymer System Master Alarm Light (motor, equipment, and valve failures not alarmed separately).

Blender Mixer rpm (if applicable).

System timers

System Elapsed Time Meter.

Elapsed Time Meter for each tank that displays the amount of time a new batch of polymer has aged. The timer shall reset when the high switch in the tank being filled is energized.

Run, Off, and Alarm Lights for transfer pump, blender drive, (if applicable) and water control valves and transfer valves.

High/Alternate/Low Aging Tank level Alarm Lights (3 lights).

Low Water Supply Pressure Alarm Light.

Major components to be installed inside the control panels shall include the following items:

Control relays.

Magnetic starters.

Circuit breakers.

Auxiliary power transformers to transform 480 volt, 3 phase to 240 volt, single-phase, three-wire, with the midpoint grounded to serve all pump controller circuits and 120 volt control circuits.

Main 480 volt, 3 phase power service circuit breaker disconnect.

2.6.05 Metering Pumps. Metering pumps shall be furnished and installed as indicated on the drawings to dispense prepared polymer solution.

Each pump shall include local and remote electrically controlled metering of solution under the following conditions and requirements:

Each pump shall be of the progressing cavity type, having materials of construction selected for resistance to the pumped solution, at least Type 316 stainless steel and EPDM synthetic rubber. Each pump shall be a heavy-duty universal pin joint type. The pump and drive shall be mounted on a structural steel baseplate complete with a drip rim, drainage connection, and suitable guards.

Each pump shall have a stable head-capacity curve and be free from cavitation and objectionable noise. Pumping heads and other terms shall be as defined in the standards of the Hydraulic Institute.

Suction and discharge nozzles shall have ANSI 125 pound flanges and shall be tapped and plugged for a pressure gauge connection. Each pump stuffing box shall be tapped at the lantern ring position for an outside water seal connection. The pumps shall be furnished with Durametallic "Type RO" mechanical seals. Each pump shall be arranged for side suction and end discharge. Each pump shall be provided with a high discharge pressure switch.

Each metering pump shall be equipped with a dc motor of minimum rating 180 volt dc, suitable for operation from a rectified 208 volt, 60 Hz, single phase power supply.

Each pump shall be equipped with a control enclosure housing an electronic SCR drive and the auxiliary control devices specified herein. The control enclosure shall be NEMA Type 4X. Refer the sections on Pump Controls and Instrumentation.

The control enclosure shall be mounted adjacent to the pump. The supplier shall furnish power and control cable between the control enclosure and the pump motor for installation by the Contractor.

The metering pumps shall be Netzsch, Nemo Pump Division; Robbins & Myers, Moyno, Seepex “Group N” or equal.

2.6.06 Calibrating Columns. Transparent plastic calibrating columns shall be furnished and installed on the pump suction pipes. Each column shall be constructed of clear PVC or other chemical resistant, rigid, transparent plastic tubing, complete with vented top cap. Each column shall be graduated, with numerals at each graduation. Each column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on stainless steel legs.

2.6.07 Secondary Dilution Water Panel. One secondary dilution water panel shall be provided in accordance with the P&ID and as specified. The panel shall be rigidly supported or may be skid-mounted with the polymer metering pumps. The panel shall be fiberglass reinforced plastic, suitably reinforced.

All facilities shall be rigidly mounted on the panel, including piping and valves necessary for control of water, water flow meters, and other necessary appurtenances, all as indicated and required. Piping and valves shall conform to the applicable specification sections. Flow meters shall be medium vane style with digital rate indication and output of remote indicator. Each flow meter shall be provided with a nameplate indicating the point of application.

2.6.08 Static Mixers. Three in-line type static mixers shall be furnished and installed to provide intimate mixing of prepared polymer solution and secondary dilution water. The mixers shall be single element "Series 50 Mixers" as manufactured by TAH Industries, Inc., complete with removable plastic elements.

2.6.09 Diffusers. Channel type diffusers shall be provided as indicated on the drawings. The diffuser tubes shall be fabricated from stainless steel.

2.7 SULFURIC ACID FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed as indicated on the drawings, to dispense sulfuric acid. The chemical consists of 93 percent sulfuric acid with a specific gravity of 1.84.

2.7.01 Transfer Pumps. Transfer pumps shall be furnished and installed as indicated on the Drawings. Each pump shall be designed for pumping sulfuric acid from the storage tanks to the day tank.

Each pumping unit shall be of the positive displacement peristaltic type utilizing a flexible hose and shoe. Pumps shall be Alfa Laval “Model IP800” or Watson Marlow/Bredel “Model SP/65”, or equal.

Each pump shall be supplied with an integral squirrel cage induction type gear motor rated 460 volts ac, 3 phase, 60 HZ per Master Specification Section 16220, General Purpose Induction Motors-Procurement. The motor shall have a fan sized for adequate cooling of the drive at the lowest operating speed. Gearing shall be of the helical gear arrangement, classified for continuous heavy shock duty, AGMA Class II, 24-hour duty. Minimum gear reducer efficiency shall be 95 percent. The motor shall be contained in a cast iron housing suitable for corrosive duty.

The pump housing shall contain a threaded drain plug and vent port. The drain shall be located at the lowest point in the housing and allow for complete removal of all liquid from within the housing.

Discharge pulsation dampeners shall be provided with each pump. Dampeners shall be the appendage type, and consist of a two part housing, bell shaped bladder, one-way air inlet valve to prevent backflow and shall have a pressure gauge.

Two complete sets of spare parts, as recommended by pumps manufacturer, shall be provided.

Each transfer pump shall be furnished with a control panel incorporating magnetic-only adjustable circuit breaker type disconnect and motor starters with thermal overload protection. All pilot devices shall be transformer types, 1-1/6 inch (30 mm, oil tight type. Relays shall be 3PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number and coded to the approved panel drawings. The local control panel shall be pre-wired that the pump will shut down and the alarm on pump high discharge pressure can be re-started only if the alarm is reset at the local panel.

The local control panel shall include as a minimum the following:

Power ON/OFF selector switch

L/O/R selector switch

Start and Stop push buttons

“Running”, “Off”, “Discharge Pressure High Alarm”, “Bulk Tank Low Level”, “Day Tank High Level”, and “Power On” lights

RESET push button

Normally closed contacts pre-wired to terminals for external connection by others corresponding to:

“Pump Failure”

“Pump Running”

“L/O/R” switch position

Discharge Pressure High

Shall be able to accept:

Digital inputs to Start and Stop the Pump

Digital inputs from, Pump discharge pressure switch, Bulk Tank low level, and Day Tank high level.

2.7.02 <u>Metering Pumps</u>. Metering pumps shall be furnished and installed to dispense sulfuric acid to the point of application.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished. Motor shall not be less than the indicated horsepower.

Refer to Master Specification Division 17, Instrumentation and Controls for information on pump controls.

Each pump shall be of the positive displacement type, using a hydraulic plunger actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housing. Diaphragms relying solely on friction and compression of the diaphragm material for installation and leak prevention will not be acceptable.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

Inlet and outlet check valves shall be of the single valve type, with valve housings, which are removable without disassembly of threaded pipe fittings.

Materials of construction shall be selected for resistance to the pumped solution.

Each pump shall be mounted on a structural steel or cast iron base to be set as indicated on the drawings and shall include a self-lubricating speed reducer and liquid end splash guards.

Each pump shall be furnished with the following accessories:

> One back pressure valve, factory adjusted for the back pressure recommended for the pump.
>
> One internal pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacturer.
>
> One vent valve.
>
> One properly sized diaphragm type surge chamber in each pump discharge piping arrangement. Each chamber shall be fabricated of materials resistant to the pumped solution, and shall include an air charging valve and air gauge. The chamber shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.
>
> One strainer installed in the inlet piping. The strainer shall be PVDF bodied Y-pattern, with #8 mesh screen and O-ring seals.
>
> Wiring shall be furnished complete and ready for connection to external power circuit.
>
> The metering pumps shall be Wallace and Tiernan “series 43” or “Chemtube 2000”, Milton Roy "Milroyal B", or Pulsafeeder “Pulse Series 7120" or equal.

2.7.04 <u>Calibration Columns</u>. Transparent plastic calibrating columns shall be furnished and installed on the pump suction piping. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs.

2.8 CAUSTIC SODA FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed, to dispense 50% caustic soda solution, with a specific gravity of 1.54, to the points of application.

2.8.01 Day Tanks. Each day tank shall have a useful capacity as necessary for not les than 24 hours operation and shall be provided with a scale graduated in gallons. All parts of the tank shall be fabricated of translucent fiberglass reinforced vinyl ester of sufficient weight for adequate support and corrosion protection. The tank shall be flat bottom, flanged top. The tank shall include bonded flanged fittings for inlet, overflows, vent, outlet, drain, level sensors, level switches, and gauge glass. Hold down lugs shall be provided to anchor the tank to the base. All inlet and outlet connections shall be made with flexible connections.

A gasketed flanged door shall be provided on top of the tank for inspection and cleaning of the tank. The access manhole shall be 24 inches (60.96 cm) diameter minimum.

A chemical-resistant valve and gauge glass assembly shall be mounted on the side of the tank. The gauge glass shall be fabricated of clear corrosion resistant material. Steel protection rods shall be provided the full length of the gauge. Valves assemblies shall be PVC with integral ball checks to prevent flow in the event of gauge glass failure.

2.8.02 Metering Pumps. Metering pumps shall be furnished and installed as indicated on the drawings to dispense caustic soda to the points of application. Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished. Motor shall be not less than the indicated horsepower

Refer to Master Specification Division 17, Instrumentation and Controls for information on pump controls.

Each pump shall be of the positive displacement type, using a hydraulic plunger actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housing. Diaphragms relying solely on friction and compression of the diaphragm material for installation and leak prevention will not be acceptable.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

Inlet and outlet check valves shall be of the single valve type, with valve housings which are removable without disassembly of pipe connections.

Materials of construction shall be selected for resistance to the pumped solution.

The rate of metering shall be changed by concurrently varying the pump speed and stroke length.

Each pump shall be mounted on a structural steel or cast iron base to be set as indicated on the drawings and shall include a self-lubricating speed reducer and liquid end splash guards.

Each pump shall be furnished with the following accessories:

> One back pressure valve, factory adjusted for the back pressure recommended for the pump.
>
> One internal pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacture.
>
> One vent valve.
>
> One properly sized diaphragm type surge chamber in each pump suction piping arrangement. Each chamber shall be fabricated of materials resistant to the pumped solution, and shall include an air charging valve and air gauge. The chamber shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.
>
> One strainer installed in the inlet piping. The strainer shall be PVC bodied Y-pattern, with #8 mesh screen and O-ring seals.
>
> All wiring shall be furnished complete and ready for connection of an external power circuit.

The metering pumps shall be ProMinent “Makro”, Wallace and Tiernan “Series 43", Milton Roy "Milroyal B", or Pulsafeeder “Pulsa Series” or equal.

2.8.03 Calibration Columns. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs.

2.9 SODIUM BISULFITE FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed as indicated on the drawings, to dispense 38 percent liquid sodium bisulfite solution, with a specific gravity of 1.26.

2.9.01 Day Tanks. Each day tank shall have a useful capacity as necessary for 24 hours operation and shall be provided with a scale graduated in gallons. All parts of the tank shall be fabricated of translucent fiberglass reinforced vinyl ester of sufficient weight for adequate support and corrosion protection. The tank shall be flat bottom, flanged top type. The tank shall include bonded flanged fittings for inlet, overflows, vent, outlet, drain, level sensors, level switches, and gauge glass. Hold down lugs shall be provided to anchor the tank to the base. All inlet and outlet connections shall be made with flexible connections.

A gasketed cover shall be provided with a 24 inch (60.96 cm) inner diameter flanged bolted access opening that is used for inspection and cleaning of the tank.

A chemical resistant valve and gauge glass assembly shall be mounted on the side of the tank. The gauge glass shall be fabricated of clear, corrosion resistant material. Steel protection rods shall be provided the full length of the gauge. Valve assemblies shall be PVC with integral ball checks to prevent flow in the event of a gauge glass failure.

2.9.02 Metering Pumps. Metering pumps shall be furnished and installed to dispense sodium bisulfite solution to the points of application.

Each pump shall include continuous local manual/remote manual and remote auto controlled metering of solution under the following conditions and requirements.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished. Motor shall be not less than the indicated horsepower.

Refer to Master Specification Division 17, Instrumentation and Controls for information on pump controls.

Each pump shall be of the positive displacement type, using a hydraulic plunger actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housing. Diaphragms relying solely on friction and compression of the diaphragm material for installation and leak prevention will not be acceptable.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

Inlet and outlet check valves shall be of the single valve type, with valve housings, which are removable without disassembly of pipe connections.

Materials of construction shall be selected for resistance to the pumped solution.

Each pump shall be mounted on a structural steel or cast iron base to be set on a concrete support as indicated on the drawings and shall include a self-lubricating speed reducer and liquid end splash guards.

Each pump shall be furnished with the following accessories:

One back pressure valve, factory adjusted for the back pressure recommended for the pump.

One internal pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacturer.

One vent valve.

One properly sized diaphragm type surge chamber in each pump discharge piping arrangement. Each chamber shall be fabricated of materials resistant to the pumped solution, and shall include an air charging valve and air gauge. The chamber shall be sized to limit pressure surges to between 5 and 10 percent of mean pressure.

One strainer installed in the inlet piping. The strainer shall be PVC bodied Y-pattern, with #8 mesh screen and O-ring seals.

Wiring shall be furnished complete and ready for connection to external power circuit.

The metering pumps shall be ProMinent “Meta”, Wallace and Tiernan "Series 43 ", Milton Roy "mRoy ", or Pulsafeeder "Pulse Series" or equal.

2.9.03 Calibration Column. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs.

2.9.04 Diffusers. Channel type diffusers shall be provided as indicated on the drawings. The diffuser tubes shall be fabricated of Type 316, Schedule 40 stainless steel.

2.9.05 Rotameters. Rotameters shall be provided for chemical lines and shall have vertical bottom inlets and top outlets with ANSI 150 lb. (68 kg) flanged ends for vertical mounting. Rotameters shall be rated for a minimum working pressure of 150 psi (1034 kPa), shall be calibrated in gallons per minute, shall have Hastelloy C floats with an accuracy of +/- 2 percent. The Rotameter also shall have integral flow control valves for adjusting the flowrates. The body materials shall be Type 316 stainless steel ends with heavy borosilicate glass tubes and packing glands, or other materials best suited for the fluid being measured. The rotameters on the discharge side of the chemical systems shall be provided with all valve and piping mounted on a single panel. Rotameters shall be as manufactured by Brooks, Pennwalt or equal.

2.10 FILTER AID (POLYMER) FEED SYSTEM. The filter aid feed system shall be integrated equipment packages to automatically meter, dilute, mix, completely activate, and feed liquid/emulsion polymer and water.

2.10.01 Polymer Makedown Units. Each automatic polymer dilution/feed system shall consist of an integrated equipment package capable of automatically metering, diluting, activating and feeding liquid polymer and water. The system shall activate concentrated emulsion and solution polymer in a mixing vessel or multi-staged hydrodynamic blending device without moving parts. A diaphragm pump will deliver neat polymer as needed.. The system shall be an integrated package pre-piped and pre-wired.

The makedown system shall be constructed of a 304 stainless steel chassis. All hardware used for the component attachment shall be 304 stainless. Any components in contact with polymer or water shall be constructed of electroless nickel plated brass, stainless steel, or an inert plastic.

Mixing energy shall be provided by a motor-driven stainless steel multi-bladed turbine. Turbine shall rotate on a stainless steel shaft supported by stainless steel sealed, lubricated ball bearings and mechanical seals. Mixing chamber shall be transparent. All metallic materials of construction shall be 304 stainless steel or electroless nickel-plated brass.

Metering pumps shall be controlled by a device capable of both manual and remote control and of automatic remote in response to a 4-20 mA input signal - one for remote control of speed and one for control of stroke with a device able to be unistrut or wall-mounted. The control device shall include an on/off switch, an LCD display showing pump operating parameters in strokes per minute, strokes per hour or RPM, and a dial to adjust polymer input rate to the system by varying stroke frequency or RPM of the pump.

The system shall include loss of flow sensor which, sensing that water flow has been interrupted for any reason, will place the polymer pump on standby and will restart it automatically when flow is restored. A pressure regulator shall be provided. Differential pressure switches shall be provided to monitor the differential pressure in the mixing chamber**,** placing the polymer pump on standby when the differential pressure drops below minimal values. Indicator light shall come on.

Refer to Master Specification Division 17, Instrumentation and Controls for information on pump controls.

Unless otherwise shown, all polymer mix/feed pumps shall be mounted on concrete pedestals and they shall be equipped with the following accessories:

Solenoid valve for on/off control of dilution water supply.

Rotameter flow indicator

Rate adjusting valve.

All polymer mix/feed pumps shall be furnished with a complete set of the manufacturer's suggested spare parts, such as seals, packing, gaskets, O-rings, and any other parts subject to wear. Where applicable, one set of spare bearings shall be furnished with each piece of equipment.

The system shall have a 304 stainless steel or brass solenoid valve for on/off of dilution water supply, and a rotameter-type flow indicator equipped with integral rate-adjusting valve. The flow indicator shall be machined acrylic with a valve stop and guided float. Water flow rate shall be adjustable.

Acceptable manufacturers include the following or equal:

Stranco (Bradley, Illinois), "Polyblend"

Fluid Dynamics, "Dynablend"

2.10.02 Transfer**/**Recycle Pumps. Polymer transfer/recycle pumps shall be furnished. The pumps will also be capable of recycling the storage tanks contents to keep the polymer emulsified. Each pump shall operate under the following conditions and requirements:

Each pump shall be of the progressing cavity type, constructed of materials selected for resistance to the pumped solution, at least Type 316 stainless steel and EPDM synthetic rubber. The pump shall be heavy-duty, universal pin joint type. The pump and drive shall be mounted on a structural steel baseplate complete with a drip rim, a drainage connection, and suitable guards.

Each pump shall have a stable head-capacity curve and be free from cavitation and objectionable noise. Pumping heads and other terms shall be as defined in the Hydraulic Institute Standards. Each pump shall be provided with a high discharge pressure switch and a pressure switch isolator, to stop the pump on excessive discharge pressure.

Suction and discharge nozzles shall have ANSI Class 125 pound flanges and shall be tapped and plugged for a pressure gauge connection. The pump stuffing box shall be tapped at the lantern ring position for an outside water seal connection. Each pump shall be furnished with Durametallic "Type RO" mechanical seals or equal.

Each pump shall be supplied with an electric motor. Each motor shall be squirrel cage induction type, horizontal, totally enclosed fan cooled, premium efficient, rated 460 volts, 3 phase, 60 Hz, and shall conform with the requirements of Master Specification Section 16220, General Purpose Induction Motors-Procurement.

If the motor is not shop tested with the pump, certified motor efficiency data shall be furnished to the pump supplier based on tests conducted on the motor or an identical motor.

Each pump shall be furnished with a control panel incorporating magnetic-only adjustable circuit breaker type disconnect and motor starters with thermal overload protection. All pilot devices shall be transformer type, 30 mm, oil tight type. Relays shall be 3PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings.

The local control panel shall be wired that the pump will shut down and alarm on pump high discharge pressure, low discharge flow and low seal water pressure and can be re-started only if the alarm is reset at the local panel.

The local control panel shall include as a minimum the following:

Power ON/OFF selector switch

L/O/R selector switch

Start and Stop push buttons

“Running”, “Off”, “ Day Tank High Level Alarm”, “ Bulk Tank Low Level Alarm”, “ High Discharge Pressure Alarm”, “Low Seal Water Pressure”, Low Discharge Flow and “Power On” lights

RESET push button

Normally closed contacts pre-wired to terminals for external connection by others corresponding to:

”Pump Failure”

“Pump Running”

“L/O/R” switch position

Discharge Pressure High

Low Seal Water Pressure

Low Discharge Flow

Shall be able to accept:

Digital inputs to Start and Stop the Pump

Digital inputs from Day Tank high level switch, Pump discharge pressure switch, Low Seal Water Pressure, Low discharge flow switch and Bulk Tank low level switch.

The transfer pumps shall be Allweiler Pump Inc.; Netzsch, Nemo Pump Division; or Robbins & Myers, Moyno or equal.

2.10.03 Day Tanks. Each day tank shall have a useful capacity as necessary for 24 hours operation and shall be provided with a scale graduated in gallons. All parts of each tank shall be fabricated from translucent fiberglass reinforced vinyl ester plastic material of sufficient weight for adequate support and protection. The tank shall be flat bottom, flanged top type. The tank shall include bonded flanged fittings for inlet, overflows, vent, outlet, drain, level sensors, level switches, and gauge glass. Hold down lugs shall be provided to anchor the tank to the base.

All inlet, overflow and outlet connections to the tank shall be made with flexible connections. A gasketed cover shall be provided with a 24 inch (60.96 cm) minimum diameter flanged bolted access opening that is used for inspection and cleaning of the tank.

A chemical resistant valve and gauge glass assembly shall be mounted on the side of the tank. The gauge glass shall be fabricated of clear and corrosion resistant material. Steel protection rods shall be provided the full length of the gauge. Valve assemblies shall be PVC with integral ball checks to prevent flow in the event of a gauge glass failure.

2.10.04 Polymer Booster Pumps. Polymer booster pumps shall be furnished to transfer neat polymer. Each pump shall operate under the following conditions and requirements:

Each pump shall be of the progressing cavity type, constructed of materials selected for resistance to the pumped solution, at least Type 316 stainless steel and EPDM synthetic rubber. The pumps shall be heavy-duty, universal pin joint type. The pump and drive shall be mounted on a structural steel baseplate complete with a drip rim, a drainage connection, and suitable guards.

Each pump shall have a stable head-capacity curve and be free from cavitation and objectionable noise. Pumping heads and other terms shall be as defined in the Hydraulic Institute Standards.

Each pump shall be provided with a high discharge pressure switch and a pressure switch isolator, to stop the pump on excessive discharge pressure.

Suction and discharge nozzles shall have ANSI Class 125 pound (56.6 kg) flanges and shall be tapped and plugged for a pressure gauge connection. The pump stuffing box shall be tapped at the lantern ring position for an outside water seal connection. Each pump shall be furnished with Durametallic "Type RO" mechanical seals or equal and shall be arranged for side suction and end discharge.

Each pump shall be supplied with an electric motor. Each motor shall be squirrel cage induction type, horizontal, totally enclosed fan cooled, premium efficient, rated 460 volts, 3 phase, 60 Hz, and shall conform to the requirements of the Master Specification Section 16220, General Purpose Induction Motors-Procurement.

If the motor is not shop tested with the pump, certified motor efficiency data shall be furnished to the pump supplier based on tests conducted on the motor or an identical motor.

The booster pumps shall be manufactured by Allweiler Pump Inc.; Netzsch, Nemo Pump Division; or Robbins & Myers, Moyno or equal.

2.10.05 Calibration Column. One transparent plastic calibrating column shall be furnished and installed on the blender suction pipe as indicated on the drawings. Each column shall be mounted on a steel stand. The column shall be as manufactured by Valcom or equal.

2.10.06 Diffusers. Channel type diffusers shall be provided as indicated on the drawings. The diffuser tubes shall be fabricated of PVC.

2.11 PHOSPHORIC ACID (CORROSION INHIBITOR) FEED SYSTEM. One assembly of feeding equipment shall be furnished and installed.

2.11.01 <u>Day Tanks</u>. Each day tank shall have a useful capacity as necessary for 24 hours operation and shall be provided with a scale graduated in gallons. All parts of each tank shall be fabricated from translucent fiberglass reinforced vinyl ester plastic of sufficient weight for adequate support and protection. The tank shall be flat bottom, flanged top type. The tank shall include bonded flanged fittings for inlet, overflows, vent, outlet, drain, cross connection, level sensors, level switches, and gauge glass. Hold down lugs shall be provided to anchor the tank to the base.

All inlet and outlet connections shall be made with flexible connections.

A gasketed cover shall be provided with a 24 inch (60.96) minimum diameter flanged bolted access opening that is used for inspection and cleaning of the tank.

A chemical resistant valve and gauge glass assembly shall be mounted on the side of the tank. The gauge glass shall be fabricated of clear and corrosion resistant material. Steel protection rods shall be provided the full length of the gauge. Valve assemblies shall be PVC with integral ball checks to prevent flow in the event of a gauge glass failure.

2.11.02 <u>Metering Pumps</u>. Metering pumps shall be furnished and to dispense the phosphoric acid to the points of application.

Each pump shall include continuous local and remote electric and local manual mechanically controlled metering of solution under the following conditions and requirements.

Motor horsepower for each pump shall be based on the above requirements and on the discharge back pressure required by the pump furnished. Motor shall be not less than the indicated horsepower.

Refer to Master Specification Division 17, Instrumentation and Controls for information on pump controls.

Each pump shall be of the positive displacement type, using a hydraulic plunger actuated diaphragm. The diaphragm shall have an integrally molded O-ring for installation in the pump housing. Diaphragms relying solely on friction and compression of the diaphragm material for installation and leak prevention will not be acceptable.

Metering pumps shall have an internal drive shaft connected to a motor with support bearings on both ends within the gear case. Each pump shall have one adjustable head.

Inlet and outlet check valves shall be of the single valve type, with valve housings, which are removable without disassembly of pipe connections.

Materials of construction shall be selected for resistance to the pumped solution.

The rate of metering shall be changed by concurrently varying the pump speed and stroke length.

Each pump shall be mounted on a structural steel or cast iron base to be set as indicated on the drawings and shall include a self-lubricating speed reducer and liquid end splash guards.

Each pump shall be furnished with the following accessories:

> One back pressure valve, factory adjusted for the back pressure recommended for the pump.
>
> One internal pressure relief valve sized to pass the maximum displacement of the pump. The pressure setting shall be as recommended by the pump manufacturer.
>
> One vent valve.
>
> One properly sized diaphragm type surge chamber in each pump discharge piping arrangement. Each chamber shall be fabricated of materials resistant to the pumped solution, and shall include an air charging valve and air gauge. The chamber shall be sized to limit pressure surges to between 5-10% of mean pressure.
>
> One strainer installed in the inlet piping. The strainer shall be PVC bodied Y-pattern, with #8 mesh screen and O-ring seals.

All wiring shall be furnished complete and ready for connection of an external power circuit.

The metering pumps shall be Prominent “Meta”, Wallace and Tiernan "Series 43", Milton Roy “mRoy", or Pulsafeeder "Pulsa Series" or equal.

2.11.03 <u>Calibration Column</u>. One transparent plastic calibrating column shall be furnished and installed on the pump suction piping as indicated on the drawings. The column shall be Valcom, Inc., "Model 8500", or equal, and shall be mounted on steel legs.

2.11.04 <u>Diffusers</u>. Channel type diffusers shall be provided. The diffuser tube shall be fabricated of PVC.

2.12 CHLORINE FEED SYSTEM. Feeding equipment shall be furnished to dispense chlorine solution to the points of application.

2.12.01 Container Scales. Electronic load cell scales of the digital indicating type shall be provided. Each scale shall be designed for floor surface mounting. Each scale shall include a digital electronic indicator with capacity of transmitting a loop powered 4-20 mA dc signal to a remote control system. The indicator shall have the capacity of displaying net, gross, and tare weights. The indicator shall include a digital keyboard for indicating programming and tare weight entry.

Each scale shall withstand eccentric loading and container impact. Each weigh frame shall be equipped with the required number of frame-mounted, grease lubricated, carbon steel roller trunnions to facilitate rotation of the containers.

Each scale shall be Eagle Microsystems "Weigh Trunnion WT3600" with "UW12000 Weight Indicator" or Force Flow Equipment "Model DR160 and DR240" with "Wizard 4000 Indicator" or equal.

2.12.02 Evaporators. Electrically heated, thermostatically controlled evaporators for converting liquid to gas shall be provided. The evaporators shall be vented to the outside of the building through vent piping terminating with a turned-down elbow.

The evaporators shall be Capital Controls "Model VAX 4690C" or Wallace & Tiernan "Series 50-200", and shall have an evaporating capacity of 10,000 pounds of chlorine per 24 hours. Each evaporator shall be housed in an FRP enclosure. All electrical equipment shall be wired complete and ready for connection of power supply and remote circuits.

The following items shall be included with each evaporator:

Insulation on water bath tank.

Automatic water level control and low level alarm switch with alarm relay for closure of the gas pressure reducing and shutoff valve and for remote annunciation.

Water level gauge.

High and low temperature alarm switches with alarm relays for remote annunciation. The low temperature alarm relay shall operate to close the gas pressure reducing and shutoff valve.

Gas pressure gauge.

Gas temperature gauge.

Water temperature gauge.

Adjustable water temperature control thermostat.

"On-Off", single-pole, double-throw selector switch in 120 volt control circuit.

Cathodic protection with meter.

Lifting eyes and spare gaskets.

Pressure relief system, including rupture disc, alarm pressure switch with pilot light, and relief valve.

A unit-mounted disconnect switch.

Magnetic contactor for evaporator electric heaters.

A NEMA rated size 2, 120 volt coil combination magnetic motor starter for 480 volts, 3 phase, with thermal magnetic circuit breaker, but without overloads, in an FRP NEMA Type 4X enclosure. Provide a control power transformer with two primary fuses and capacity for all control items at 120 volts secondary, with one lead fused and one lead grounded. All items shall be mounted in same enclosure. Provisions shall be included for locking the cover closed and the circuit breaker "Off".

Isolated contact outputs for "Evaporator On" to the SCADA System of Division 17 and a common alarm.

Controls and power to automatically open the gas pressure reducing and shutoff valve when the evaporator is running and to close it on the abnormal conditions specified under the valve portion of this specification.

All remote signal wiring and power wiring shall terminate on numbered, pressure type copper terminal blocks. The terminal blocks shall be grouped together in a common location such as the equipment controller or a separately mounted, completely prewired, NEMA Type 4X FRP terminal box.

The local panel provided for each evaporator shall be pre-wired to provide the following signals to the PCS:

Evaporator running Status

Evaporator Power Failure

Evaporator bath Low Level

Evaporator bath High Level

Evaporator bath Low Temperature

Evaporator bath High Temperature

Chlorine gas low temperature

2.12.03 Low Temperature Switch. A low temperature switch shall be provided in the outlet piping of each evaporator to sense the entry of liquid into the gas piping. The switch will be normally closed on normal chlorine gas temperature, allowing operation of the electrically operated gas pressure reducing and shutoff valve, and will open on low chlorine gas temperature to close the gas pressure reducing and shutoff valve.

2.12.04 Gas Filters. Gas filters shall be provided on the outlet piping from each evaporator as indicated on the drawings. Each unit shall have two chambers to act as both a gas filter and a condensate trap. The filters shall be Chlorine Specialties "Model C-282 Chlorine Gas Filter".

2.12.05 Chlorine Feeders. Solution feed, vacuum operated, variable orifice type chlorine feeders, Capital Controls "Series 4000" or Wallace & Tiernan "Series V2000" or equal. The orifice and rotameter size and orifice positioner to be provided with each feeder.

In addition to the orifices and rotameters furnished with the chlorine feeders, spare orifice and rotameter assemblies shall be furnished. The assemblies shall include all necessary seals, o-rings and hardware required to install the rotameters and orifices.

Each feeder shall be equipped with a linear-scale, variable-area flowmeter which will indicate the quantity of gas being fed with an accuracy of plus or minus 4 percent of indicated flow rate over a 20 to 1 range. The meter shall be readily removable for cleaning or change of flow range and shall be direct reading in pounds per 24 hours.

2.12.06 Chlorine Solution Injectors. Operating vacuum for each feeder shall be created by a properly sized, water-operated injector mounted. The injector shall be manufactured from the same manufacturer as the chlorine feeder.

2.13 SODIUM HYPOCHLORITE FEED SYSTEM. Furnish, install and test variable speed sodium hypochlorite feed pumps and appurtenances. Interface with variable frequency controller to vary gpm output of the pump in proportion to process flow.

The pump shall be the positive displacement gear type with hastelloy C shaft housing, hastelloy C drive gear, teflon idle gear and carbon/graphite wearplates, and internal mechanical seal. The mechanical seal shall not require seal water.
The pumps shall be self-priming. The pump shall be designed to be disassembled without breaking pipe connections.

Mount each metering pump and motor on a fabricated steel base epoxy coated to resist sodium hypochlorite. Pump and motor shall be coupled with an approved type flexible coupling with OSHA guard.

2.13.01 Manufacturers. Provide products of Eco Gearchem Pump, Rochester, N,Y.orequal.

2.13.02 Motors. Provide each pump with a 460 volt, 60 Hz, 3 Phase, TEFC motor with antifriction bearings lubricated for life per Section 16220 of Electrical Division 16. The motor shall operate smoothly with a variable frequency controller in response to flow volume.

Pump motors shall be non-overloading over entire operating range of the pump.

2.14 LOCAL PUMP CONTROL PANELS. Each pump shall be provided with a local control panel (LCP) with the following minimum components/output and control.

An electronic SCR drive.

Shall be able to accept a remote 4- 20mA signal to control the rate of feed by varying the speed of the pump.

Shall be able to accept a remote 4- 20mA signal to control the rate of feed by varying the stroke length of the pump (Wherever applicable).

Shall be able to provide a 4-20mA signal for indication at a remote control system.

Shall be able to accept 2 remote digital inputs to start and stop the pump.

Shall provide contact for remote signaling to a remote control system of “Remote” status

“Running” and “Fail” status.

Shall provide volt free contacts for pump discharge pressure high and discharge low flow.

Shall have “Local/Off/Remote” selector switch.

Shall have power “On/Off” selector switch.

Shall have local indicating lights for “Running”, “Off” and “Power on” status.

Shall have local speed adjustment.

Shall have local stroke adjustment(except for progressive cavity type pumps).

Shall have Alarm lights for High discharge pressure, Low discharge flow and Low seal water pressure (if applicable).

Shall have push buttons for Start, Stop and Reset.

All pilot devices shall be transformer type, 30 mm, oil tight type. Relays shall be 3PDT, 10 ampere, 120 VAC rated. All wiring shall be terminated in pressure type terminal strips. All internal panel wiring shall be tagged with a unique wire number, coded to the approved panel drawings.

The rate of metering shall be changed by varying the pump speed or by concurrently varying the pump speed and stroke length (wherever applicable), as required to meet the specified metering range of the pump, unless specified otherwise.

The rate controllers shall be mounted adjacent to the pumps and shall be furnished with an engraved nameplate indicating the controlled unit. Each controller shall operate from a 120 volt, single phase, 60 Hz power supply, and shall be mounted in a NEMA Type 4 enclosure.

Each pump shall be Hardwire interlocked, such that the pump will stop:

On High Discharge Pressure

Low Discharge Flow

Low Seal Water Pressure (if applicable)

In local mode the chemical feed system shall be started and stopped from the local control panel and speed and stroke can be adjusted locally, with no control possible from a remote control system. In remote mode all control is transferred to a remote control system.

2.15 SHOP TESTING. Factory test operation of each piece of motor driven equipment. All tests to be in accordance with the latest edition of the Hydraulic Institute Standards. Provided certified test report for each pump.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with drawings, specifications, and recommendations of the manufacturer, unless exceptions are noted by the Contractor. All items necessary for a complete operating system shall be installed.

3.2 FIELD QUALITY CONTROL.

3.2.01 Acceptance Tests. After installation of equipment, give each pump a running test in presence of Engineer to demonstrate its ability to operate without vibration or overheating, and to pump solution satisfactorily in proportion to (simulated) water or wastewater flow. Correct or replace promptly defects or defective equipment revealed by or noted during tests at no expense to Owner, and if necessary, repeat tests until results acceptable to Engineer are obtained. Furnish all labor, piping, equipment, and materials necessary for conducting tests. Provide signed test documentation at test conclusion.

Start-up and demonstrate each pump operation in cooperation with the variable frequency control supplier for feed systems utilizing VFD units.

Make all adjustments necessary to place equipment in satisfactory working order at time of above tests.

In event that Contractor is unable to demonstrate to satisfaction of Engineer that units will satisfactorily perform the service required and that they will operate free from vibration and heating, the pumping units may be rejected. Contractor shall then remove and replace the equipment at his own expense.

3.3 SPARE PARTS. The Contractor shall supply the following spare parts in labeled boxes. Quantities are per pump type. Special tools necessary for maintenance shall be furnished by the Contractor.

2 Sets of Gears

2 Sets of Bearings

1 Set of Wear Plates

2 Sets of O-Rings

4 Shaft Seals

1 Pulsation Dampener

1 Variable Speed Drive Controller

1 Diaphragm Back Pressure Control Valves

End of Section

SECTION 11800

CENTRIFUGES

PART 1 – GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of centrifuges.

1.2 GENERAL.

1.2.01 Governing Standards.

American Society for Testing and Materials (ASTM) Publications:

A36- Specification for Structural Steel
A48 – Specification for Gray Iron Castings
A480 – Specification for Flat-Rolled Stainless and Heat Resisting steel Plate, Sheet and trip
A500 – Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM G65 – Practice for Conducting Dry Sand / Rubber Wheel Abrasion Test

American National Standards Institute (ANSI)

B15 – Ball Bearings, Local Bearings and Fatigue Life
B16.1 – AN Standard for Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800

Steel Structures Painting Council (SSPC): SP10 – Near Whit Blast Cleaning

Hydraulic Institute: Current Standards

Anti-Friction Bearing Manufacturers Association (AFBMA)

National Electrical Manufacturers Association (NEMA)

Underwriters Laboratories Inc. (UL)

National Electrical Code (NEC)

Institute of Electrical and Electronic Engineers (IEEE): IEEE Std-85: Test Procedures for Airborne Sound Measurements on Rotating Electric Machinery

American Gear Manufacturers Association (AGMA)

Instrument Society of America (ISA)

1.3 QUALITY ASSURANCE. Provide centrifuges, main drives, back drives, lube oil system, controls and all other specified herein as a complete integrated package for proper coordination and compatibility of equipment. Centrifuge manufacturers shall have a material quality assurance system to ensure that material specifications are met, and shall permit inspection of this system at the request of the owner. Shop tests as specified. The centrifuge manufacturer shall have manufactured ten centrifuges of the type (high solids >25% cake) and size (29 or 36-inch diameter bowl) specified herein (within the last three years), the centrifuge manufacturer shall have a minimum of ten operating centrifuges of the type (high solids >25% cake) and size (29 or 36-inch diameter bowl) being specified, for dewatering municipal sludge. The centrifuge manufacturer shall have manufactured the proposed type (high solids >25% cake) and size (29 or 36-inch diameter bowl) of centrifuge for at least 10 years. All anchor bolts, nuts, and washers shall be AISI Type 316 stainless steel. The size and spacing are to be determined by the centrifuge manufacturer.

1.4 SUBMITTALS. The Vendor shall submit to the Engineer for review and acceptance the following items in accordance with the requirements of Master Specification Section 01080, Project Submittals.

Written guarantee that the proposed centrifuges (6 or 8) are capable of meeting the performance requirements specified in paragraph 2.3.

Building layout showing the size of centrifuges in the Building Plan including control panels, bowl drive, back drive system, lubrication system and screw conveyors.

Overall plan and elevations showing dimensions, weights and handling instructions for delivery and installation.

Shop Assembly, Erection and Schematic Drawings, showing layout and clearances necessary around and above the units, details of construction, dimensions and anchor bolt locations.

Product Data including full details of controls.

Size, dimension and detail of bowl, scroll, piping, feed nozzles, discharge port, wash water, drainage connections, centrate and cake discharge chutes, adjustment devices, alignment devices and complete control description including schematics and wiring diagrams.

Materials of Construction shall include Centrifuge Bowl, Bowl Heads, Scroll Conveyor, Wear Tiles, Bowl Wear Strips, Feed Chamber, Feed Parts, O-

Rings, Cake Discharge Parts, Cake Discharge Area Housing, Feed Pipe, Upper Housing, Lower Housing, Removal Cover, Base Frame, Discharge Chutes.

Rotative speeds of bowl and conveyor, and operating G-force.

Differential speed range.

Vibration isolator details.

Gear unit details.

Oil lubrication system details.

Performance curve showing feed rates verses brake horsepower.

Estimated bearing life.

Standard Warranty.

Verification of previous experience with this size and type of equipment, including location, number of units, percent solids of feed and cake and number of years in service.

Manufacturer Information shall include Assembly Factory Location, Centrifuge Service Centers, US Headquarters, and Sales Offices.

Unit Weights and loads shall include a) Dead load due to unit weight empty b) Dead load due to unit weight full of sludge c) Dynamic loads d)Combination of b and c above.

Shipping Weight (lbs, Kg) shall include Drive, Bowl, Conveyor and Complete Assembly.

Complete list of recommended spare parts and special tools.

Estimated life of conveyor surfacing material.

O& M Manuals per Master Specification Section 01160, Training and Operations & Maintenance Manuals.

Estimated maximum noise levels in decibels at 3 feet from centrifuge. a) At factory operating with water b) Installed at DWSD operating with sludge feed under design condition.

Recommend cleaning instruction, procedures and safety precautions for equipment. Provide detailed cleaning instructions for particular cleaning system as specified.

Control Panel shop drawings shall include Outline, Ladder Logic diagrams, Equipment interconnect drawings, Bill of materials and catalog cuts of components, Nameplate schedule, Clarifications and exceptions, Written description of all instrumentation and control system, List of functions monitored, controlled and alarmed, Centrifuge serial communication I/O listings, Sequence of operation, Catalog cut sheets, and Harmonic filter details.

Motor starter panel shop drawings shall include Outline, Electrical Schematic Drawings, Wiring Diagrams, Bill of Materials and Catalog Cuts Sheets for All Devices, VFD Data Sheets, and Motor Starter Data Streets.

Setting plans with tolerances for anchor bolts.

Typical field inspection and test report.

Test reports that certify that all abrasion resistant materials supplied are in accordance with ASTM G65, Procedure A.

Recommendations for both short and long term storage of each major component.
Weights and lifting points of all equipment and sub-assemblies. Identify any special handling requirements.
Typical centrifuge sound pressure level ratings outlined in AMCA (Standard 301), including back drive at manufacturing location and at speed specified.
Electrical power demand at specified rate.

Bearing Life: Certified by a professional engineer. List life and calculation each centrifuge bearing.

Main bearing temperature operating range for the service conditions specified.
Motor nameplate data and typical motor test results.

Shop and field-testing procedures with equipment to be used.

Training lesson plan.

1.5 DELIVERY, STORAGE, AND HANDLING. Delivery and storage requirements are described in Master Specifications Section 11050, Equipment General Provisions.

1.5.01 Handling. Prior to shipment, the centrifuge units shall be disassembled as required into components weighing less than 30,000 pounds each (capacity of the centrifuge room bridge crane). Accessory equipment shall be boxed separately from the centrifuge unit. The centrifuge units shall not be lifted by eyebolts on the bearing housings or on the case. The bolt holes provided at these parts are to be used to lift these individual parts only. Machines equipped with fume seals shall be lifted by slings fastened around the base in order to avoid damage to seal assemblies.

1.6 WARRANTY. Centrifuges and all associated products and parts should be covered under warranty per Master Specifications Section 01170, Warranties and Bonds.

PART 2 – PRODUCTS

2.1 GENERAL. The centrifuges shall be of the solid bowl, horizontal, continuous feed scroll type with the cake and centrate being continuously discharged.

2.2 SERVICE CONDITIONS. General Requirements shall include that centrifuges shall be suitable for dewatering wastewater treatment residuals consisting of a blended gravity thickened primary and oxygen waste activated sludge with the aid of a polymer conditioner. Each centrifuge shall be designed for continuous or intermittent operation. The Process Description shall include that the thickened residuals will be pumped through a central header to the centrifuges with adjustable speed sludge feed pump. The dewatered sludge will be discharged to a solids-receiving screw conveyor. The solids receiving conveyor will convey dewatered residuals to belt conveyor, which will discharge to either incinerators or a lime mixing facility. Centrifuge centrate will be drained to the plant sewer.

2.3 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each centrifuge shall be a completely integrated unit designed for continuous operation and designed to meet the following requirements:

General Mechanical requirements shall include model, number of units required, minimum bowl diameter (inches), minimum bowl length(inches), design bowl speed (rpm), Maximum main drive motor speed(rpm), maximum back drive motor speed (rpm), connected horsepower of main drive and back drive, maximum footprint without oil lubrication pump unit* length and width.

*Note: the location of the oil lubrication pump unit is to be proposed by the manufacturer.

Performance requirements shall include the following:

Normal Operation

Hour/day	24
Days/week	7
Number of units operating	6 or 8

Design polymer feed concentration 0.30 % (*)

Performances at 2.0 – 6.0 percent dry solids influent residuals concentration from a blend of primary (50% by weight-minimum) and oxygen waste activated sludge.

Total (all new machines together) minimum design feed rate (lbs DSS/hour)	32,000
Minimum cake concentration (percent dry solids)	34
Minimum cake solids capture (percent)	92

Solids Capture:

$$\%Capture = \frac{FC[Corr] - CentC}{FC[Corr]} x \frac{CakeC}{CakeC - CentC} x100\%$$

Where FC[Corr] is calculated as follows

$$FC[Corr] = \frac{SF(gpm)}{SF(gpm) + PF(gpm)} xFC$$

Where FC[Corr] = Corrected Feed Total Solids Concentration (%TS)
CentC = Centrate Concentration (%TSS)
CakeC = Cake Total Solids Concentration (%TS)
SF = Sludge Feed (gpm)
PF = Polymer Feed (gpm)
FC = Feed Total Solids Concentration (%TS)

Maximum polymer dosage, 18 active lbs/dry ton feed solids*
*Based on use of GLWA WRRF house polymer; Note: polymer can be diluted at each machine after polymer flow meter.

Maximum power usage(kwh/gpm) 0.80

Contractor to verify that the selected machine fits in the layout arrangement shown while meeting all OSHA and operation and maintenance requirements. Space needs to be allowed for feed tube and scroll and bowl removal.

2.4 ACCEPTABLE MANUFACTURERS. The acceptable centrifuge manufacturers and models, which are acceptable to submit bids, are as follows: Baker Hughes (CP-3094), Alfa Laval (DS-706, Baker Hughes (CP-3084) and Westfalia (CA755)

2.5 MATERIALS.

Base Frame Assembly	Cast iron ASTM A48; fabricated steel, ASTM A36 or a combination of both.
Case	Stainless steel, AISI Type 304 or 316
Bowl	Stainless steel, AISI Type 316 or 329 or 2205
Scroll Conveyor	Stainless steel, AISI Type 316 or 329 of 2205
Abrasion-Resistant Material 1. Most Sever Service	Sintered tungsten carbide with volume loss of 3 cubic millimeters or less when subjected to an abrasion test in accordance with ASTM G65, Procedure A; minimum 15,000 hours of operation
2. Moderately Severe Service	Aluminum ceramic, sintered tungsten carbide, or flame sprayed tungsten carbide with volume loss of 12 cubic millimeters or less when subjected to an abrasion test in accordance with ASTM G65, Procedure A; minimum 15,000 hours of operation.
3. Least Severe Service	Satellite 40, Coast 53, aluminum ceramic, or sintered tungsten carbide with volume loss of 40 cubic millimeters or less when subjected to an abrasion test in accordance with ASTM G65, Procedure A; minimum 15,000 hours of operation.
Flexible chute connectors & discharge skirts	Fiber reinforced Neoprene, 1/8-inch minimum thickness.
Centrate and Solids discharge Chutes	Stainless steel, AISI Type 304

Guards	Carbon steel, 11-gauge minimum thickness, conforming to OSHA standards.
Drive Pulleys	High strength zinc-plated carbon steel or ductile iron.
Fasteners	
Bowl Assembly	Stainless steel, AISI Type 316.
Other internal locations subject to contact with residual centrate, or vapors or wash water.	Stainless steel, AISI Type 316.
3. External case, flexible connections, centrate and residual chutes	Stainless steel, AISI Type 316

2.6 CONSTRUCTION.

2.6.01 Orientation. The orientation of the centrifuges shall be as shown on the drawings for the six and eight unit layouts.

2.6.02 Base-Frame Assembly. The base-frame assembly shall rigidly support the centrifuge and drive assemblies and shall be furnished with lifting eyes or facilities that will permit the lifting of the entire assembled centrifuge unit. Machined surfaces shall be provided at all points where support loads are transferred to the base.

2.6.03 Case. The rotating bowl assembly shall be completely enclosed in a fabricated case in order to contain and direct the solids and liquid discharge from the unit. The case shall act as a protective guard and minimize noise levels. The upper portion of the case shall be provided with lifting eyes or lugs and shall be provided with inspection ports at each end. The inspection ports shall be of such size to allow internal adjustments to be made without removing the upper case. The bottom portion of the case shall be provided with flanged outlets for the attachment of the solids and centrate chutes or hoppers. A flanged and gasketed seal shall be provided between the upper and lower case components. Flange bolts shall be stainless steel.

2.6.04 Bowl. Each centrifuge shall consist of a centrifugally cast cylindrical-conical solid bowl in which a scroll conveyor mounted on inner bearings fits concentrically. The bowl wall shall include longitudinal strips or grooves, evenly spaced and extending over the full length of the bowl, designed to trap a protective layer of feed solids between the bowl wall and scroll conveyor. Leak tight connections shall be provided between the bowl and bowl ends. The pool depth in the bowl shall be adjustable through the use of plate dams at the large diameter end of the bowl where the centrate is discharged. Solids shall be discharged from the opposite end. The solids discharge ports shall have field-replaceable liners that surround the entire discharge port area, made of abrasion-resistant material for “most severe” service. Field balancing shall be accomplished by adjustments that do not involve grinding or welding.

2.6.05 <u>Bearings</u>. Two main bearings shall support the entire rotating assembly. Each main bearing shall be cylindrical or spherical roller bearing-type. The bearings shall be oil-lubricated with an external circulating lube oil system. Main bearings shall have an AFBMA L_{10} rating without adjustment factors of 100,000 hours at the specified operating conditions. The main bearings shall be housed in horizontal pillow blocks having lifting eyes or lugs. Thrust imposed upon the scroll conveyor shall be taken by separate thrust bearings. Thrust bearings shall be grease-lubricated, ball or roller bearing-type installed in the driven sheave that forms the bearing housing. Thrust bearings shall have an AFBMA L_{10} rating without adjustment factors of 100,000 hours at the specified operating conditions. Scroll conveyor bearings shall be bail or roller bearings, grease lubricated, protected by seals, and with external grease lines, or shall be self-lubricated bushings of bronze construction with graphite inserts <u>(or approved alternate)</u> and protected from product contamination. Bearings shall have an AFBMA L_{10} rating without adjustment factors of 100,000 hours at the specified operating conditions.

2.6.06 <u>Scroll Conveyor</u>. Each centrifuge shall include a stainless steel horizontal scroll conveyor. The scroll conveyor shall be equipped with helical flights designed to fit within the bowl. Feed ports shall have field-replaceable liners that surround the entire feed port area, made of abrasion-resistant material for “most sever” service. Wearing edges of the conveyor shall be constructed of field-replaceable tiles of abrasion-resistant material for “most severe” service and shall be furnished between the solids discharge and two flight lengths past the feed port as a minimum. The remainder of the scroll conveyor shall be furnished with abrasive-resistant material for “least severe” service. Solid flights welded to the scroll body are required. Ribbon designed flights will not be allowed unless they can be shown to significantly improve centrifuge performance.

2.6.07 <u>Vibration Isolators</u>. Each centrifuge unit and motor shall be mounted on spring or rubber-type isolators. The number, capacity, design, and vibrator constant of the isolators shall be as recommended by the isolator manufacturer for the load and impact resulting from operation of the centrifuge. Each isolator shall be provided with built-in leveling bolts and resilient shocks to control oscillation and withstand lateral forces in all directions. Housings shall be cast semi-steel or welded steel and springs shall be oil tempered high carbon chrome-vanadium steel. The centrifuge shall be mounted on anti vibration isolators guaranteed by the centrifuge manufacturer to control the vibration within the required limits. The isolator shall be designed such that the dynamic load does not exceed 1.05 times the static load. A maximum of 2.0 mils of displacement peak to peak measured on centrifuge pillow blocks at maximum operating speed will be acceptable under dry shop test conditions. Sensors shall be provided to monitor the vibration on the frame and/or gear housing.

2.6.08 Oil Lubricating System. An external pressure lubricating system shall be mounted on or adjacent to each centrifuge. It shall provide a controlled flow of filtered and cooled oil to each main bearing and shall consist of a reservoir, oil pump of adequate capacity with fractional horsepower motor, oil filter, water-cooled temperature controlled oil cooler, oil flow indicators, thermal switches, pressure gauge, relief valve, thermometers, and flexible hose lines. The oil cooler shall be a heat exchanger designed to maintain the temperature of the lube oil leaving the exchanger within the maximum limits for satisfactory operation of the centrifuge provided, giving due consideration to the quantity of heat to be removed, the type and quantity of the lube oil, and the temperature of the lube oil coming to the exchanger. The exchanger shall fulfill these requirements using not more than the amount of water indicated in the Service Water Connections paragraph of this section for cooling at a maximum ambient air temperature of 101 degrees F. The heat exchanger shall be of the oil-to-water type. The fouling factor, as defined by the Tubular Exchanger Manufacturers' Association Standards, shall be not more than 0.002. The pressure drop through the heat exchanger shall not exceed 5 psi for the cooling water. The oil pump controls will be interlocked with the centrifuge motor starter so that the oil pump has to be running before the centrifuge can be started. Oil temperature switches shall be furnished in the oil return lines or the pillow block bearings to stop the centrifuge on high bearing oil temperature. A flow or pressure switch shall be furnished in the oil line and a level control shall be furnished in the oil reservoir to stop the centrifuge or prevent it from starting on low oil level, flow, or pressure. The main bearing shall not be grease lubricated.

2.6.09 Influent Connections. Each centrifuge shall be furnished with flanged residuals inlet, polymer and flushing water connections. Flanges shall be flat-faced and shall conform to ANSI B16.1, Class 125 Dimension and Drilling. Flexible connections are required at each influent connection as specified herein. Machines using a nozzle or port smaller than 1-3/16 inches in any dimension to either introduce residuals into the centrifuge or to discharge dewatered residuals from the centrifuge bowls will not be acceptable.

2.6.10 Flexible Connections. All piping connections and the centrate and solids chutes shall be equipped with flexible connections. The flexible connections shall be flanged, ribbed, fabricated from neoprene and shall have 12 inches minimum laying length at the piping connections and a minimum laying length of 12 inches at the centrate and solids chutes. The flexible connections shall be bolted directed to the flanged outlets of the centrifuges, unless indicated otherwise. Stainless steel bolts with stainless steel retainer plates shall be provided at each end of flexible connections. No exterior loads are to be transferred to the centrifuge units. Flexible connections shall be designed to accommodate lateral and vertical movements of not less than 3/8 inch. Electrical conduits connected to the centrifuge equipment shall be installed with flexible connections. The arrangement of flexible connections shall be as recommended by the equipment manufacturer for the anticipated vibration and movement between centrifuge and rigid conduit termination.

2.6.11 Centrate Chute. A 3/16-inch stainless steel chute shall be provided for the centrate connection to each centrifuge. Each chute shall be welded construction, free from offsets and projections that might impede the flow of centrate. All joints shall be continuously welded and watertight. The inlet connection shall be coordinated with the flexible connection attached to the centrifuge. The outlet connections shall be compatible with the piping connections as indicated on the drawings. A vent connection, a sample pipe, and centrate spray nozzle connections shall be provided on each chute. The chute shall be provided with anchor bolts and anchor bolt templates. A centrate sampling port shall be provided in the centrate discharge, above the operating floor elevation. The centrifuge Manufacturer shall coordinate the design, installation, and operation of the chute with the piping provided by others.

2.6.12 Solid Discharge Chute. The solids discharge chute will be provided by the receiving screw conveyor supplier. The centrifuge supplier shall coordinate the design of the solids discharge chute with the receiving screw conveyor supplier.

2.6.13 Centrate Spray Nozzle. Two centrate spray nozzles for foam control shall be furnished for each centrate chute in locations recommended by the Manufacturer. Nozzles shall be cast bronze or Type 304 stainless steel, providing a solid cone-shaped spray pattern with a round impact area and spray cone angle between 120 and 130 degrees. Nozzles shall be Spraying Systems Co., Wheaton, IL, “13 (1/2-inch) Full Jet H-W small capacity (6 gpm)” or equal.

2.6.14 Shop Painting. Centrifuge is to be brown, gearbox yellow and motor orange. All other painting requirements are as described in Master Specification Section 09900, Painting.

2.7 DRIVE UNITS.

2.7.01 General. The centrifuge bowl shall be driven by variable frequency drive (VFD) controlled alternating current electric motor. The scroll conveyor back drive can be either powered by a VFD controlled alternating current electric motor and a cyclo or planetary gearbox or powered by a hydraulic drive unit with a constant speed electric motor. The centrifuge Manufacturer shall be responsible for coordinating the load and drive components to ensure that a complete and properly operating system is furnished. All equipment shall be derated as recommended by the drive Manufacturer for reduced-speed operation with an adjustable frequency drive.

2.7.02 Scroll Conveyor Back Drives. The back drive system shall provide automatic, torque-controlled regulation of relative scroll speed, corresponding to changes in feed concentration or quality. The back drive shall automatically maintain a preset torque input to the scroll by allowing the differential speed to vary. The back drive shall operate in such a manner that as the reactive torque of the scroll increases due to an increased solids inventory in the bowl caused by fluctuating feed concentration, the scroll speed shall gradually increase and conversely, as the inventory and resultant reactive torque decreases, the scroll differential speed shall decrease within an adjustable range. Torque-based adjustment shall be a function of input to the driven unit. The back drive shall offer a minimum differential speed range adjustment of 0 to 20 rpm. Each centrifuge unit shall be protected from damage as a result of high torque overload. A thermal overload protection system on the drive motor shall not be considered sufficient protection for the gear unit, but shall also be provided.

2.7.03 Alternating Current Back Drives. VFD driven ac back drives shall be equipped with a Cycle speed inducers, or planetary gear box, unit which shall control the differential speed between the centrifuge bowl and conveyor. The gear unit shall generate a torque capacity to meet the expected service conditions, but not less than 220,000 inch-pounds. The centrifuge manufacturer shall select the reduction gear ratio required to handle the solids obtained and to be consistent with satisfactory results. The gear units shall be lubricated by a built-in circulating oil lubrication system.

2.7.04 Hydraulic Back drives. Hydraulic back drives hall be supplied with a hydraulic reservoir complete with water-cooled temperature controlled heat exchanger and necessary filters. The necessary controls, tachometers, hoses, pressure gauges, and appurtenances to monitor the operating condition of the back drive and provide alarm and overload interlocks shall be provided. If hydraulic overload interlocks are electric, these controls shall be clearly indicated on control wiring diagrams prepared by the Manufacturer in accordance with the submittals section. Hydraulic back drives shall be water-cooled, shall have a minimum torque capacity of at least 292,000 inch-pounds and shall be of a design such that no gear reducer is required in the scroll conveyor drive train. The electric motor supplied with the hydraulic scroll drive shall be TEFC 460 volt, 3 phases 60 Hz with 1.15 service factor NEMA design B.

2.7.05 Direct Current Back Drives. Direct current (dc) back drives will not be acceptable.

2.7.06 Electric Motors. All motors provided shall conform to Master Specifications Section 16220, General Purpose Induction Motors except as modified herein. Motors shall be horizontal, squirrel-cage induction type rated 460 volts, three phase, and 60 Hz motor torques shall be adequate for the operating conditions. Motors shall have a 1.15 service factor. All motors shall be provided with a totally enclosed fan cooled (TEFC) enclosure with lifting lugs. Thrust and guide bearings shall be self-cooled, grease lubricated and shall be provided to withstand any momentary thrust and normal loads imposed on the motor. Antifriction bearings shall have an AFBMA L10 rating without adjustment factors of 40,000 hours at the specified operating conditions. Each motor shall be provided with an engraved nameplate stating the bearing identification and the type and weight of lubricant required. The continuous operation of the centrifuge equipment over the extreme operating feed rate ranges as specified shall not exceed the motor nameplate horsepower rating. Each motor shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heater shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply. Space heaters shall be wired to a separate terminal box from the motor terminal box. Space heaters shall be powered from the centrifuge motor control circuits at 120 volts ac and shall be energized only when the motor is off. With the motor at ambient temperature, it shall be capable of making two complete starts in succession with coasting to stop between starts. Each motor shall be capable of at least one restart within one hour after any shutdown. Each main drive motor shall have a minimum guaranteed efficiency of at least 94 percent. Each main drive motor shall be furnished with an oversized motor terminal box suitable for termination of up to two 4-inch conduits. Main drive and back drive motors shall be furnished with at least one automatically reset motor winding temperature switch per phase to trip off the motor on high temperature an alarm at the centrifuge control panel. Temperature switch contacts shall be wired in series, with the end leads brought out to a separate terminal box from the motor terminal box. Switches shall be as recommended by the motor manufacturer. Each motor used in conjunction with an variable frequency drive shall be specifically selected for service with an variable frequency type speed controller an shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. The motor shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG1, part 31. Each motor used in conjunction with a variable frequency drive shall be provided with a warning nameplate on the motor to remind the operator to trip the main breaker prior to performing maintenance.

2.7.07 Base. Each drive unit shall be mounted on a rigid cast iron or fabricated steel base. The drive units shall be furnished with an adjustable, sliding base to adjust tension in the V-belt drive. Jacking screws shall be used to permit movement of the motor without the need to realign the motor after its sheaves and belts have been changed.

2.7.08 Sheaves and Belts. A matched set of V-belts shall be provided at each centrifuge. Motor sheave sizes shall be as selected by the centrifuge manufacturer for the specified application. Sheaves other than those furnished with equipment shall not be used without acceptance by the Engineer. V-belt and sheave groove dimensional tolerances shall be in accordance with the Engineering Standards for Multiple V-Belt Drives as published by the Multiple V-Belt and Mechanical Power Transmission Association.

2.8 CONTROLS. Each centrifuge unit shall be provided with a complete configured control system as required for safe and satisfactory operation of the unit. Each centrifuge shall be provided with a freestanding centrifuge control panel to be installed in the Control Room and a separate AFD panel to be installed adjacent to the centrifuge.

2.8.01 Centrifuge Control Panel Construction. The centrifuge control panel shall be a NEMA type 12 enclosures constructed of a least 12-gage stainless steel, with doors on the front. Access to the rear of the panel shall not be required. Enclosure doors shall be essentially full height, gasketed, continuously hinged type. In addition to the door retaining clips, each door shall be provided with a chrome-plated three-point latch and a single oil-tight operating handle for maintenance. The panel shall house all electronic instruments, controls, indicators, and the programmable logic controller.

2.8.02 Centrifuge Control Panel Operator Interface and Alarms. The operator interface unit shall be able to auto or manual start/stop as well as provide displays of the following: centrifuge drive motor amps, sludge desired and actual flow rates, polymer desired and actual flow rates, pre-set and actual operation time, grinder operation, cake discharge screw conveyor. The elapsed time meter shall be a six (6) digit, non-reset register type, with the last digit reading tenths of an hour. Fault Alarm and Shut down Conditions.

Faults that shall provide “alarms” include sludge feed header low pressure faults, grinder faults, polymer system low header pressure, and cake conveyor fault.

Faults that shall provide “alarm and shutdown” include main motor overheated, main drive malfunction, excessive vibration, back drive motor overheated, back drive malfunction, torque alarm, torque alert, lube pump overload, low lube oil flow-front pillow block bearing, low lube oil flow-rear pillow block bearing, excessive return oil temperature-front pillow block bearing, excessive return oil temperature-rear pillow block bearing, low differential speed, and centrifuge bowl over speed.

2.8.03 VFD Panel Construction. The VFD panel shall be a NEMA Type 4x enclosure constructed of at least 12-gage stainless steel with doors on the front. Access to the rear of the panel shall not be required. In addition to the door retaining clips, each door shall be provided with a chrome-plated three-point latch and a single oil-tight operating handle for maintenance. Provide closed loop top mounted air conditioners (120 volt) for all NEMA 4X stainless steel panels that have VFD’s. An adjustable thermostat shall be provided for panel enclosure temperature regulation. The operating temperature inside the panels shall be maintained to be

15% below the rating of VFD solid state devices. The panel shall house motor starters, variable frequency drives, control power transformers, power monitors, ac line reactors, and harmonic filters.

2.8.04 Panel Size and Arrangement. The centrifuge control panel and VFD panel shall be freestanding. Both panels shall be of the same height (72 to 90 inches) and the same nominal depth (24 to 36 inches) to assure flush alignment. Devices on the face of the panels shall be located not more than 60 inches above the panel base.

2.8.05 480 Volt Components. The VFD panel shall include provisions for terminating the 480-volt, 3 phase service for the centrifuge equipment on terminal blocks. Control voltage for motor starters, lights, relays, timers, auxiliaries, and for the centrifuge control panel shall be 120 volts, single phase from a control power transformer in the AFD panel. All controls shall be suitable for a supply voltage variation of ±10 percent. A voltage regulation transformer shall be provided if required.

The AFD panel shall be equipped with a main circuit breaker disconnect with an external operating handle. The circuit breaker shall be thermal magnetic type, and shall have an interrupting rating of at least 65,000 amperes at 480 volts.
Control power transformers shall be sized to handle all simultaneous loads. Control power transformers shall have primary leads fused, one secondary lead fused, and one secondary lead grounded. Motor starters for each ac motor not driven by a VFD shall be furnished in the VFD panel. Three phase starters shall be circuit breakers combination type, consisting of 3 phase, 60 Hz contactors with thermal overloads, a 120-volt ac coil, and a circuit breaker disconnect. Starters shall be NEMA rated for the motors furnished, and shall be at least NEMA Size 1. Circuit breakers shall be 600-volt magnetic motor circuit protectors. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism. Each complete 3-phase starter shall have an interrupting rating of at least 65,000 amperes at 480 volts. The starters for the grinder and screw conveyor shall be included in the centrifuge starter panel.

Each VFD furnished in the VFD panel shall include an input circuit breaker, line reactor, and harmonic filter. Harmonic filters are not necessary if deemed so by the manufacturer. AFDs shall be UL listed and labeled and shall comply with the latest applicable standards of ANSI, NEMA, IEEE, and NEC. The variable frequency controller drive shall convert input power of 480 volt ac (±10 percent), 3 phase, 60 HZ (±2 percent), into an adjustable frequency output in an ambient temperature of 0°C to 40°C at the installed conditions on the jobsite. Each drive shall be of sufficient capacity and shall produce a quality output waveform for step-less speed control throughout the operating range. The controller shall be suitable for, and coordinated with, the thermal, electrical, and mechanical characteristics of the motor furnished. The variable frequency drives shall be of the 18 pulse width modulated, adjustable frequency inverter type, with a full-wave diode bridge rectifier to convert incoming ac voltage to a controlled dc voltage. The dc voltage shall be inverted to an adjustable frequency output. The inverter output shall be generated by insulated gate bi-polar transistors that shall be controlled by six identical base-driver circuits. The adjustable frequency output shall be capable of providing variable or constant volts/Hz excitation to the motor terminals up to the nominal 60 Hz rating. The inverter output carrier frequency shall be adjustable up to 6,000 Hz. The drive shall maintain a displacement power factor of 0.95 or better over the entire speed range. The drive shall have self-diagnostics for detection of failed electronic circuitry. The drive shall include fault detection and trip circuits to protect itself and the connected motor against line voltage transients, over temperature, power line under voltage and over voltage and output over current. The drive shall be protected by fast acting, current limiting input fuses. The drive shall be capable of sustaining 110 percent of motor rated full load current. The drive shall have a current limiting feature to prevent output currents greater than 100 percent of rating.

Each drive shall have a membrane keypad with integral 2-line, 24-character minimum LCD display mounted through the AFD panel door. The keypad shall be capable of setting all drive parameters and controlling drive operation, including manual/automatic operation modes, start/stop control, speed control, and alarm/trip reset functions. The drive shall have microprocessor-based digital logic control fully programmable from the front panel display with nonvolatile memory for the programmed functions. Maximum speed shall be field adjustable. The speed shall increase or decrease at a linear time ramp, independently adjustable for acceleration and deceleration control. The minimum speed (zero point), and the maximum speed (span) shall be independently fielded adjustable. Local set points shall be entered to the controller via the front panel controls. The input circuit breaker shall be thermal magnetic or instantaneous-trip type, and shall have an interrupting rating of at least 65,000 amperes at 480 volts. Variable frequency drives shall be protected from incoming voltage transients with an input ac line reactor. AC line reactors shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the drive input power devices. AC line reactors shall be K-rated per IEEE C57-110 and shall be TCI “Model KLR’, or equal.

Harmonic filters shall utilize an interlocking contactor that shall be automatically operated by the drive run circuit. The filter shall be sized as recommended by the filter manufacturer for the motors and drives furnished. Harmonic filters shall be TCI “Harmonic Guard Series”, or equal.

The power monitor shall measure the total power in kilowatts supplied to the centrifuges. All required current transformers (CTs) and potential transformers (PTs) should be provided installed, and interfaced with the power monitoring system. The power use shall be displayed on the face of the panel and shall be connected as an input to the PLC to allow remote monitoring.

2.8.06 Programmable Logic Controller (PLC). The centrifuge monitoring, control and interlock logic shall be performed by a redundant programmable logic controller (PLC) located in the centrifuge control panel. The PLC shall be Allen-Bradley SLC 5/03 or equal. The PLC shall be capable of seamlessly integrating into the OWS system. The centrifuge operation will be remotely monitored. All safety interlocks and permissive from external equipment shall be hardwired to/from the centrifuge control panel. One spare processor and one spare of each type of PLC card, including power supply, shall be provided. Analog inputs and outputs shall be 4-20 mA dc. Discrete inputs and outputs shall be 120 volts ac. A minimum of 25 percent spare input/output (I/O) and 40 percent spare memory shall be provided. Spare processor shall be connected in a hot standby mode.

PLC software shall be completely configured and programmed by the Centrifuge Supplier. The Supplier shall furnish a laptop computer for maintaining the software. Supplier shall furnish a computer file copy of the PLC program and a printout of the PLC ladder logic. The printout shall be documented to clearly indicate the function of each rung in the logic. In addition, the printout shall include memory usage documentation to indicate all memory locations used. A dedicated port for connection of a cable to a programming device shall be provided on the PLC.

Local Operator Interface (LOI) Device shall be of a graphic display type and operator interface device to monitor and control the centrifuge and its entire ancillary systems shall be provided on the face of the centrifuge control panel. The unit shall be similar to an Allen Bradley Panel View. In addition to the LOI mounted on the centrifuge panel, Supplier shall provide local controls for maintenance testing mounted in each starter panel to be installed in close proximity of each centrifuge for local operation. These controls shall have pushbuttons for starting and stopping individual centrifuge components. Also provided will be monitoring run and stop lights.

A" software programmer" representative of the centrifuge supplier shall attend a software coordination meeting to coordinate issues such as the PLC address usage and interface requirements for communicating data to the OWS system. The meeting will be held at the project site after the centrifuge installation contract commences. A representative of the OWS system supplier/integrator will attend the meeting.

2.8.07 Machine Monitoring System. A vibration and temperature monitoring system shall be provided for the centrifuge main bearings. Vibration monitoring shall use a vibration transmitter and a snap action switch, or a solid state dual set point vibration switch for sensing vibration. Set-points shall be for alarm and shutdown. Vibration in excess of predetermined displacement shall automatically shutdown the machine. Vibration amplitude shall be indicated in the Centrifuge Control panel. The temperature monitoring system shall be a Basler "Model BE4-49R" or equal.

2.8.08 Centrifuge Control Operation. Each centrifuge shall be furnished with controls to operate as specified below. Controls shall include interlocks to associated equipment furnished by others such as the sludge grinders, sludge pinch valves, polymer pinch valves, cake solids screw conveyors, and SFE wash water supply valve. The sludge grinders and cake solids screw conveyors motor starter and controls shall be provide in the Centrifuge starter panel. See specification Section 17105 for the controls description and the Instrumentation and Control Centrifuge P & ID drawings for the control logic.

PART 3 – EXECUTION

3.1 INSPECTION.

3.1.01 Shop Testing. Each centrifuge unit shall be tested in the manufacturer's shop for mechanical performance, including vibration and noise, before shipment. Test shall be conducted using water as attesting medium. The Owner Engineer and Contractor shall be allowed to observe the testing with 2 weeks' written notice before testing begins. The testing procedure shall be submitted to the Engineer for record purposes.

Scroll Conveyor Abrasion Test for testing the abrasion-resistant material to be used shall be tested for abrasion in accordance with ASTM G65, Procedure A. The test shall be performed at a laboratory certified to conduct the test. The type of material proposed and the service conditions shall meet the requirements for abrasion resistance. Copies of the certified laboratory test report shall be submitted in accordance with the submittals section.

The Motor Shop Test shall be done by manufacturer and furnish complete certified performance test data on one main drive motor. The test shall conform to IEEE Report 112A, Forms A-1 and A-2. Tests may be performed on motors from this purchase or on previously tested electrically identical motors. If such data is to be furnished from tests on electrically identical motors, the Contractor shall so state. If the complete test is to be run on one motor to be furnished, the manufacturer shall notify the Engineer as stipulated in the quality control section. The motor manufacturer shall furnish the Engineer, through the centrifuge manufacturer, a sketch of the test setup showing the equipment and instrumentation to be used. Test points shall include ¼ load, ½ load, ¾ load, full load, and service factor load. Motors and certified test data shall be delivered to the centrifuge manufacturer before final assembly of the units is stated. If the motors fails to operate properly, or fails to meet the testing requirements during testing, the manufacturer shall modify or repair all motors for this contract and perform additional tests. Provisions for witnessing additional tests are covered in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.1.02 Field Quality Testing. Manufacturers Field Installation and Checkout Services: The centrifuge Manufacturer shall provide the services of a qualified field representative to assist during installation, mechanical/electrical checkout and startup of the equipment by the Contractor. As a minimum, the centrifuge Manufacturer's field representative shall be made available as follows, travel time excluded.

Initial installation assistance (2 trips)	8 days (total)
Checkout assistance (3 trips)	12 days (total)
Startup assistance (4 trips)	20 days (total)

The centrifuge Manufacturer shall also supply and install all oil, grease. And hydraulic fluids required for initial operation.

3.1.03 Field Mechanical Electrical Test. In conjunction with startup, after installation and mechanical and electrical checkout of the units and after all accessories are in operable condition, a Field Mechanical Electrical Test shall be performed by the Contractor under the supervision of the centrifuge Manufacturer in the presence of the Engineer. Each unit shall be subjected to a complete normal start, normal stop, and emergency stop cycles. Each unit shall then be subjected to a 4-hour running test. At the beginning and end of the test and at periodic intervals between, all thermometers, pressure gauges, and flow indicators shall be observed and recorded. All safety devices shall be checked for satisfactory operation. The no-load amperage of the motor shall be checked and recorded. The start timer and acceleration time to running speed shall be checked and adjusted, if necessary. The belt tension shall be adjusted at the end of the test, checked and readjusted, if necessary, at the end of the test, and complete instructions given to the operator for further check and adjustment at the end of an additional 72 hours of operation. Any malfunctions appearing during the tests shall be corrected and additional testing performed, as directed by the Engineer to assure that the defective or maladjusted equipment will perform satisfactorily after adjustment.

3.1.04 Field Performance Tests. A performance test shall be run on each centrifuge unit after the installation is complete and the units are operating properly as determined by the representative of the centrifuge Manufacturer. The performance test shall be conducted by a capable representative of the centrifuge manufacturer and accepted by Engineer. The Owner's operating personnel shall assist the centrifuge Manufacturer's representative in the performance test. A designated representative of the Contractor and the Engineer shall observe the performance test. As a minimum the Manufacturer's field representative shall be made available as follows for the performance tests, travel time excluded: Performance testing (trips as required - 30 day total). At least 2 weeks prior to the proposed testing date, the Contractor shall notify the Engineers of the testing date and shall submit a report from the centrifuge Manufacturer detailing the proposed performance testing procedure and analyses. Proposed data collection sheets shall be submitted for review.

Preliminary field tests shall be conducted using the centrifuge unit under the design conditions specified. Preliminary field tests shall consist of a series of runs to determine the appropriate pool depth, operating torque, and polymer dosage to meet the design conditions.

Extended Duration Field Tests shall be conducted to demonstrate the equipment's ability to consistently perform at the design conditions specified after the appropriate operation parameters are established. Each centrifuge unit shall be operated for a minimum of 48 consecutive hours under design operating conditions. The centrifuge manufacturer's representative shall adjust machine operation at the start of each 8 hour shift and shall make no further adjustments during each 8 hour shift unless specifically authorized by the Engineer. Each centrifuge shall be tested on successive days for the service conditions specified. The test results will be used to prove compliance with the performance requirements specified in paragraph 2.3 prior to acceptance of the equipment. Consistent compliance with design conditions shall be defined as the average of all sample values meeting or exceeding the specified performance requirements. A protocol shall be developed for the 48 hour test. This will include but not be limited to the following: No more than 2 centrifuges may be tested at one time. The average operating data for each 24 hour period of the 48 hour test shall have to meet the performance criteria. Each machine being tested shall be equipped with a temporary watt meter. Essentially steady state operation shall be maintained throughout the test. The centrifuges will be required to maintain acceptable performance while dewatering residuals with characteristics within the specified ranges. WWTP house (See Appendix A) liquid emulsion polymer shall be the only polymer used as a basis of centrifuge performance.

Samples shall be taken at approximately one-hour intervals during the test. The following test determinations shall be made on the appropriate sample. For Influent Flow, determine the flow rate of the gravity thickened residuals entering the centrifuges. For Influent Solids, determine the solids concentration of the gravity thickened residuals entering the centrifuges. For Dewatered Residual Solids, determine the percent solids concentration of the dewatered residuals discharged from the centrifuges. For Centrate Solids, determine the suspended solids concentration of the centrate discharged from the centrifuges.

Samples will be collected as directed by the Engineer, and analyses performed by an independent testing laboratory. Parallel samples may be collected for analyses by others. The Engineer shall initial all data sheets. The polymer usage (pounds per dry ton of solids in centrifuge influent residuals) shall be measured and recorded during the dewatering performance test. The polymer consumption rate shall be calculated and recorded using the polymer flow rate liquid polymer concentration, and subsequent polymer dilution as required. The consumption rate shall be measured and recorded hourly during the steady state performance tests, and the polymer consumption rate shall be the average rate over the testing period. Should the equipment not achieve consistent compliance during the extended tests or require a higher polymer dosage than that specified to achieve compliance then the centrifuge manufacturer should modify the equipment and repeat the field evaluation tests. Costs of modifying equipment or subsequent retesting shall be borne by the centrifuge manufacturer. Additional equipment shall include all items specified or indicated to be part of the dewatering system.

3.1.05 Field Evaluation Report. The Contractor shall prepare a written report within 10 days after completion of the tests presenting the results of the field evaluation tests. The report shall include all laboratory analysis reports and recorded data and observations as specified. Six copies of the report shall be submitted to the manufacturer and the Engineer within 30 days after completion of the specified tests. The report shall include all data collected during field testing, including, but not limited to, the following:

Results of preliminary test runs to select pool depth, operating torque, and polymer dosage. Data from extended duration testing to demonstrate consistent achievement of design conditions for the centrifuge, including at least hourly data for residuals feed rate, feed solids concentration, polymer consumption rate, centrate suspended solids concentration, cake solids concentration. Conclusions from extended duration field testing utilizing the average of the data collected, including hydraulic throughput (gpm), solids throughput dry (tons/hr), cake consistency (percent dry solids), solids capture efficiency (percent), polymer type, and polymer use (lbs/dry ton solids.

A complete solids balance shall be developed form flow metering together with the solids concentration tests. Solids balance calculations shall be used to verify the accuracy of measured quantities.

3.1.06 Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the vibration displacement (peak-to-peak) as measured at any point on the centrifuge pillow block bearing housing shall not exceed 2.0 mils without residuals feed. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3. A vibration monitoring and shutdown system shall be provided to shut down the centrifuge upon excessive vibration.

3.1.07 Noise Levels. Sound generated by all centrifuges (one at a time running by itself) shall not exceed 92 dBA at a free field distance of 3 feet in any direction under load as installed, in accordance with ANSI S1.4-1971 specifications. If the sound exceeds 92 dBA, the equipment shall be modified or a sound attenuation package shall be provided at no additional cost.

3.2 INSTALLATION. Install all items in accordance with the manufacturer's printed instructions as indicated and as specified.

Make necessary adjustments to place equipment in satisfactory working order and ready for acceptance testing.

3.3 SERVICE AND MAINTENANCE. Centrifuge manufacturer shall service and maintain all centrifuge equipment according to the general conditions and the following requirements. After installation by the Contractor, the centrifuge manufacturer shall service and maintain all centrifuge equipment until all centrifuge equipment has successfully completed all performance testing. All service and maintenance during this period shall be furnished by the centrifuge manufacturer at no additional cost.

3.4 EQUIPMENT IDENTIFICATION AND MANUFACTURERS NAMEPLATES.

3.4.01 Equipment Identification. Each centrifuge denoted by a symbol and an identifying number in the Specifications or on the Drawings shall be provided with permanent plastic or metal identification nameplates. An identification nameplate shall be placed on each starter panel, back drive panel, control panel, and centrifuge. Identification used shall be the same as the symbol indicated in the Specifications or on the Drawings and shall be located in a conspicuous place as acceptable to the Contracting Officer. Plastic nameplates shall be made of laminated material and shall have engraved letters extending through the black face into the white layer. Letters shall be approximately 1 inch tall. Nameplates shall be mechanically fastened to the equipment surface.

3.4.02 Manufacturer’s Nameplate. Each major component of equipment shall have the manufacturer’s name and address, and equipment model number and size on a nameplate securely affixed to the equipment. The nameplate of the distributing agent only will not be acceptable.

End of Section

SECTION 11820

COMMINUTORS

PART 1 – GENERAL

1.1 SCOPE. This section covers the furnishing and installation of comminutors (including sludge grinders, scum grinders, etc.).

Each comminutor unit should include at minimum a grinder, reducer, motor and control panel.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Equipment furnished and installed under this section shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer.

All electrical equipment shall conform to applicable standards of Division 16, Electrical.

1.2.02 Governing Standards

American Society of Testing and Materials (ASTM).

Anti-Friction Bearing Manufacturers Association.

National Electric Code.

American Iron And Steel Institute

Underwriters' Laboratory (UL).

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. Manufacturer shall have a minimum of 5 years of experience of producing substantially similar equipment, and shall be able to show evidence of at least 5 installations in satisfactory operation for at least 5 years in the continental United States.

1.3.02 Field Quality Control. Supplier shall provide the services of a factory-trained representative to check installation and to start-up each comminutor. Factory representative shall have complete knowledge of proper installation, operation and maintenance of equipment supplied. Representative shall inspect the final installation and supervise a start-up test of the equipment.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Drawings and Data should be submitted as specified in Section 01080, Project Submittals.

1.4.02 Operations and Maintenance Manuals. CONTRACTOR shall provide Operation and Maintenance manuals in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING.

Delivery, storage, and handling of comminutors, and all associated parts are to take place as specified in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.6 WARRANTY

The products shall be warranted against any defects in material or workmanship per Master Specification Section 01170, Warranties and Bonds.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS.

2.1.01 General. Furnish equipment suitable for the process and service conditions as described. All grinders will normally receive intermittent discharges of scum and/or sludge from facilities associated with the Work. Grinder shall be capable of operating without a hot water system.

2.2 ACCEPTABLE MANUFACTURERS
Products shall be supplied by any of the following manufacturers: Monofolo, Inc of Houston, TX, or JWC Environmental, Inc. of Costa Mesa, CA

2.3 CONSTRUCTION.

2.3.01 Cutting Elements. The inside configuration of both the individual cutters and the individual spacers shall be hexagonal so as to fit the shafts with a total clearance not to exceed 0.009 inch across the flats. Individual cutters and spacers shall be AISI 4140 Heat Treated Alloy Steel, surface ground for uniformity and through-hardened to a minimum 45-50 Rockwell C. Cutter configuration shall consist of one shaft with individual 5-tooth double-edged cutters and one shaft with individual 11-tooth cam cutters. To maintain particle size, the height of the tooth shall not exceed 5/16-inch (8 mm) above the root diameter. Cutter to cutter root diameter overlap shall be not less than 1/16-inch (1.6 mm) or greater than ¼-inch.

2.3.02 End Housing and Covers. Grinder end housings shall be cast of ASTM A 48-83 Class 40 grey iron with a cast-in-place flow deflector, designed to protect the bushings while guiding particles directly into the cutting chamber. Provide gasketed housing having standard bolted inlet for securing the grinder to the conveyor housing. Provide support frame on the outlet connection as shown on the drawings and as described herein.

2.3.03 Shafts. Grinder shall be made of AISI 4140 heat treated hexagon steel with a tensile-strength rating of not less than 149,000 psi. Each shaft hex shall be a maximum thickness of 2 inches.

2.3.04 Seals. The radial and axial loads of the shafts shall be borne by four sealed oversize Conrad-type ball bearings. The bearings shall be protected by a combination of a tortuous path device and end face mechanical seals. Face materials must be a minimum of tungsten carbide to tungsten carbide, not requiring an external flush or any type of lubrication. The mechanical seal shall be rated at 90-psi continuous duty by the seal supplier. The bearings and seals shall be housed in a replaceable cartridge that supports and aligns the bearings and seals, as well as protects the shafts and end housings. O-rings and seal wedges shall be made of Buna-N elastomers.

2.3.05 Drive Unit Assembly. Drive unit assembly shall have a speed reducer and electric motor connected by a flexible direct shaft coupling. Speed reducer shall be a grease filled cycloidal type of reducer with "Heavy Shock" load classification and enclosed in a cast iron or welded steel weatherproof casing. Speed reducer moving parts shall be immersed in oil, and bearings shall be anti-friction throughout. Casing shall be provided with inspection covers, oil fill, and drain connections and means for inspection of oil flow. Inspection, oil fill and drain covers shall be chained to the casing.

2.3.06 Side Rails. The inside profile of the side rail shall be concave to follow the radial arc of the cutters. The side rails shall be affixed to the grinder and maintain a clearance not to exceed 5/16-inch between major diameter of the cutter and the concave arc of the side rail. Each side rail shall incorporate a pocket area which provides positive location and attachment of the cleanout comb cartridges. Side rails shall be cast of ASTM A 536-84 ductile iron.

2.3.07 Cleanout Combs. Each side rail shall have a cartridge style comb which is positioned between the cutters at the outer side of each cutter stack. The cleanout combs act to strip grease and other scum materials from the backside of the grinder to prevent in-process buildup or blinding of the flow passages through the grinders. The cleanout combs shall prevent any blinding or buildup of scum material on the upstream side of the grinder.

2.4 MOTOR. Unless otherwise noted, motors shall follow requirements as described in Master Specification Section 16220, General Purpose Induction Motors.

2.5 CONTROL PANEL. Each unit shall be supplied with a programmable control unit, mounted in a NEMA enclosure as specified by Engineer. The panel shall include forward and reverse contactors, fuses, thermal overloads. Control panels, programmable control units and other modules to be contained within the panel should comply with the requirements of Master Specification Division 17, Instrumentation and Controls.

2.5.01 Operation and Alarm Sequence. The programmable control unit shall measure motor power. In the event of an overload, the controller shall cause the grinder to reverse momentarily to clear the condition. The grinder shall then return to normal operation. If the unit reverses 3 times within a 30 second period, the unit shall reverse, shut-down, and activate an alarm

2.6 PAINTING. Clean and prime ferrous metal surfaces of equipment in the shop in accordance with the requirements of Master Specification Section 09900.

PART 3 – EXECUTION

3.1 INSPECTION. Inspect and verify that structures or surfaces on which the equipment will be installed have not defects which will adversely affect installation. Inspect all equipment prior to installation. Promptly report defects which may affect the Work to the Engineer.

3.2 INSTALLATION. Install in a manner and to the tolerances recommended by the equipment manufacturer.

3.3 FIELD QUALITY CONTROL. A manufacturer’s factory-trained representative shall check and approve the installation before operation. The representative shall operate and test system in the presence of Engineer and verify that the equipment conforms to requirements, and instruct relevant personnel on care and maintenance. The representative shall revisit the Site as often as necessary until all deficiencies are corrected. Perform testing, checkout and start-up of the equipment under the technical direction of the manufacturer’s factory-trained representative. Do not energize drive system without authorization from manufacturer’s representative.

End of Section

SECTION 11975

BLOWERS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous blower units and accessories.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Contractor.

Each unit shall be furnished and installed complete with all anchors and supports; all mechanical equipment required for proper operation, including a complete drive unit; and all additional materials or construction required by the manufacturer's design.

Master Specification Section 01180, Equipment, Materials, Parts and Tools shall apply to all equipment furnished under this section.

Power supply to the equipment will be 480 volts, 60 Hz, 3 phase, unless indicated otherwise on the drawings.

1.2.02 Governing Standards. Unless otherwise specified, the work of this Section shall conform to the applicable portions of the following Standard Specifications:

AFBMA - Anti-Friction Bearings Manufacturers Association

ANSI – American National Standards Institute

ASTM – American Society for Testing and Materials

NEMA – National Electrical Manufacturers' Association

1.3 QUALITY ASSURANCE. All blower units shall be one manufacturer. The manufacturer shall be Hartzell Fan, Inc. or approved equal.

1.3.01 Manufacturers Field Services. Provide services of manufacturer's representative for start-up and acceptance testing of blower units as follows:

Align blower and motor couplings after bases have been grouted.

Shop and field test blower units specified herein.

To assist in the start-up and testing of pumping units, provide 2 man-days minimum of on site factory representative personnel. Man-day requirements do not include travel time and do not relieve the Contractor of his obligation to provide the required service to place all pump units in acceptable operation.

1.4 SUBMITTALS. Submit complete shop drawings in accordance with section on Project Submittals.

As a minimum, shop drawings shall include a bill of materials, front views, assembly drawings, discharge transition duct piece, schematics and wiring drawings.

Submit for review the name of the manufacturer, trade name and/or model designation and catalog cuts.

Submit operation and maintenance manuals in accordance Master Specification Section 01160, Training and Operations & Maintenance Manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The blower units shall meet the following design criteria:

The Blowers shall be Direct Driven with Down Blast Discharge.

All internal hardware shall be 300 series stainless steel encapsulated with fiberglass.

Blower units shall be furnished completely assembled.

Motor shall be readily accessible.

Wheel shall be flat blade radial design of one-piece construction, die formed of individual laminations of fiberglass.

The bearings shall have a minimum L_{10} life of 20,000 Hrs.

Motors shall be open end drip proof.

PART 3 - EXECUTION

3.1 INSTALLATION. Install all items in accordance with the manufacturer's printed instructions as indicated and as specified.

Make necessary adjustments to place equipment in satisfactory working order and ready for acceptance testing.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. Give each blower unit a running test in the presence of the Engineer to demonstrate satisfactory operation.

Make whatever adjustments are required to achieve a satisfactory test.

End of Section

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DIVISION 12 – FURNISHINGS **PAGE NO.**

SECTION 12100

OFFICE FURNISHINGS AND FIXTURES

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous office furnishings and equipment including all accessories and window treatments.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing Materials) D635 – Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

FS (Federal Specification) CCC-T0191b – Specification for Flame Retardancy of Textiles.

NFPA (National Fire Protection Association) 70 – Specification for National Electrical Code

NFPA 701 – Specification for Fire Tests for Flame-Resistant Textiles and Films.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturers Qualifications. Manufacturers shall have not less than 5 years documented experience in manufacture of furnishings and equipment specified in this section. Provide window shades and blinds as complete units produced by one manufacturer, including hardware, accessories items, mounting brackets and fastenings.

1.3.02 Flame Retardant Materials. Shall be approved by Michigan State Fire Marshall Office. Shade fabrics shall comply with and have passed either NFPA 701 or FS CC-T-191 test.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit layout drawings for equipment and furnishings showing proposed locations and where applicable, details of fabrication and installation. Submit data showing details of construction, dimensions of individual components, profiles and finishes. Also, include attachments, accessories, utility and service requirements and locations. Submit operation and maintenance data for products furnished under this section.

1.4.02 Samples. Submit samples of proposed finishes for color selection.

1.5 RECEIVING, HANDLING AND STORAGE. Handle and store materials carefully. Protect products from weather and other damage.

1.6 WARRANTY. Provide installation warranty for a period of 2 years against defective materials and workmanship.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Furnishings and equipment shall be provided by the following full service contracters EMCO Industries, Raymond Engineering, Steel Case or equal.

2.2 WINDOW TREATMENTS.

2.2.01 Shades. Fabrics shall be washable, flame resistant cotton duck; color as selected.

Slats shall be selected white pine or plastic; tapered at ends.

Pull shall be braided cord with rayon ring pull attached to lower hem by metal eyelet.

Roller shall be minimum 1-1/8 inch (2.9 cm) seasoned straight grained white pine with tempered steel spring, nylon bearings, and zinc coated metal parts.

2.2.02 Blinds. Slat supports shall be braided of polyester yarn and dimensionally stabilized.

Slats shall be virgin aluminum alloy 1.0 inch (2.54 cm) wide and shall have plastic type coating.

Head channel shall be 0.025 inch (0.635 mm) thick steel U-shaped with plastic type coating.

Tilt control shall consist of an enclosed worm and gear tilting mechanism.

Bottom rail shall be of 0.031 inch (0.787 mm) formed steel.

Cord shall be of adequate diameter of high strength synthetic fibers.

2.2.03 Curtain Rods. C-shaped track, minimum 0.03 inch (0.762 mm) thick roll-formed steel; manufacturer's standard white finish; by Kirsch or Graber.

2.2.04 Accessories, Brackets, Fittings and Fastenings. Suitable for proper and satisfactory installation and operation of shades, blinds, and curtain rods.

Unless otherwise specified or indicated, provide materials, construction and finishes in accordance with the manufacturer's latest catalog published at time of bidding, and with approved Samples.

2.3 COMMAND AND CONTROL CONSOLES.

2.3.01 Components. Electronic equipment enclosures also referred to as consoles, are modular and flexible components for computer workstation environments. Typical components include the following:

Equipment Positioning Kits:

CRT's.

PC Processors.

Rackmounts.

Operator Convenience Components:

Pencil Drawers.

Binder Storage Compartments.

Mobile Storage Pedestals.

Form Storage/Paper Organizer.

Keyboard Accommodation:

Under counter retractable ergonomic tray.

First level retractable tray with wrist rest as indicated on the drawings.

Console Accessory Items:

Ventilation Fans (shall be 4 inch (10.2 cm) diameter muffin fans, sized as required to extract heat to exterior of unit, with grilles).

Cable Management Trays.

Peripheral Accessory Items:

Printer Enclosures

Storage Cabinets

LAN Cabinets, Credenzas, Conference Tables, Podiums, Media Cabinets, and Chairs

2.3.02 Hardware. Utilize manufacturer's standards for hardware applications.

2.3.03 Specialty Components.

Pistons: Gas operated for maximum actuation.

Worksurface Adjustable Hardware.

CRT Adjustable Shelf.

Anti-Glare Filters.

Electric Plug Strip.

Task Lighting.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Consoles Fabrication.

Shop assembles consoles.
Fabricate each unit rigid, not dependent on building structure or adjacent units for rigidity.

Fit shelves, doors, and exposed edges with plastic edging. Use one piece for full length only.

Cap exposed plastic laminate finish edges with plastic laminate finish edges with plastic trim.

Door and Drawer Fronts shall be 3/4 inch (1.9 cm) thick overlay style.

2.4.02 Shades. Number the shades and curtain rods as to the specific locations in the Work. Provide single widths of fabric with no center seams for each shade. The shade mounting system shall allow for shade removal and replacement without dissembling hardware assembly.

PART 3 - EXECUTION

3.1 INSPECTION. Verify existing conditions before starting work, including adequacy of backing and support framing and location and sizes of utility rough-in associated with work of this section.

3.2 PREPARATION. Protect the Work and adjacent construction against damage.

3.3 INSTALLATION. Install the Work in accordance with manufacturer's instructions and approved Shop Drawings. Install wall blocking as required for wall mounted furnishings.

3.3.01 Fasteners. Use fastening devices to secure hooks to wall construction which are appropriate for type of construction being mounted to.

3.3.02 Location. As noted on drawings. Verify mounting height with Engineer prior to installation.

3.3.03 Console Installation. Consoles shall be installed by the manufacturer's factory trained installers and shall be completed as indicated in the project schedule.

Adjust doors, drawers, hardware, fixtures, and other moving or operating parts to function smoothly.

Touch up damaged finishes equal to original condition as approved.

End of Section

SECTION 12200

LABORATORY FURNISHINGS AND FIXTURES

PART 1 - GENERAL

1.1 SCOPE. This section covers laboratory furnishings, fume hoods and other laboratory equipment and fixtures including control systems materials and equipment, complete with components and accessories.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) A167 – Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

ASTM B221 – Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

ASTM B584 – Specification for Copper Alloy Sand Castings for General Applications.

ASTM C1036 – Specification for Flat Glass.

ASTM D570 – Test Method for Water Absorption of Plastics.

ASTM D635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

ASTM D638 – Test Method for Tensile Properties of Plastics.

ASTM D695 – Test Method for Compressive Properties of Rigid Plastics.

ASTM D785 – Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.

ASTM D790 – Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

NFPA 30 (National Fire Protection Association) – Specification for Flammable and Combustible Liquid Code.

NFPA 70 – Specification for National Electrical Code.

Underwriters Laboratories (UL) 913 – Specification for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1, Hazardous Locations.

1.2.02 Definitions. Conventional Hood - A fume hood with a sliding sash and fixed solid upper panel. The net opening area into the hood varies with sash position.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Indicate equipment and fixture locations. Include details of connections between units and to adjacent work, the location and size of holes and cutouts, and dimensional locations for rough-in of mechanical and electrical services.

Include system piping and electrical connections, a written description of operation, and data on equipment used including flow measuring devices and dampers.

Submit engineering data for automatic control dampers and volume control devices stating the amount of leakage, flow characteristics and construction of the device.

Furnish graphic flow diagram drawings for each system.

Label items and devices shown and indicate coordination with: submitted catalog information, proper settings and adjustments of instruments, normal condition of devices (such as normally closed dampers, normally open valves and contacts), and sizes of devices and accessories included with devices.

Submit a control diagram for each system with a complete written sequence of operation pertaining to the diagram and shown on the same drawing. Submit control sequences incorporating symbol elements from diagrams, such as D-1 Exhaust Damper.

Submit catalog sheets for every item used in the system showing two or more devices or models of a device, marked to show the specific model and/or accessories being used in the control diagram.

1.3.02 Certifications. Submit a statement of compliance for performance requirements.

Submit certification that the laboratory hood control system manufacturer has supervised the installation of the control systems in the fume hoods, including a listings of personnel, dates, and times of supervision. Manufacturer shall attest that the level of supervision provided is sufficient to accomplish a quality and well integrated installation.

Submit a statement attesting that the laboratory hood control system manufacturer understands and accepts the responsibility for the integration of these control systems into the fume hood construction, and that the control systems are functioning properly and as designed.

Submit certification that the laboratory hood control system manufacturer has supervised the installation of the interconnection of the laboratory hood control system with all other building and system controls or construction, and attests that such construction is in full compliance with the laboratory hood control system performance requirements as specified herein.

1.3.03 Samples. Submit the following samples:

Interior lining material, 12 x 12-inch (30.48 cm x 30.48 cm) size.

Working surface, with depression, 12 x 12-inch (30.48 cm x 30.48 cm) size.

Finish for sheet steel.

One full size combination drawer and cupboard base cabinet.

Submit complete operation and maintenance manuals as specified in Master Specification Section 01160, Training, Operation and Maintenance Manual.

1.3.04 Documentation and Training.

Provide thorough documentation and training to permit the Owner to perform the necessary operation and maintenance functions required by the system.

Provide 3 days of onsite training for Owner’s Personnel. Training to include, but not limited to, system operation, troubleshooting, instrument calibration, alarm handling and system reconfiguration.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

2.1.01 Operation of Metal Fume Hoods. Design conventional general purpose fume hoods to operate at the total cfm (cubic meter) and a maximum static pressure as indicated on the Drawings.

2.1.02 Hood Design. Design the fume hood so that when properly installed in a laboratory and connected to an exhaust system of the proper capacity, it will contain and remove fumes generated within the hood and will exhaust light or heavy gases efficiently.

"Properly installed" means installed in an area where there is at least 5 feet (1.5 m) of clear space in front and sufficient space on each side for observation of the airflow pattern entering the hood and where there are no cross drafts or other air currents exceeding 10 fpm (3.05 m per min.) that would affect the hood performance in the area in front and around the hood.

Design hood to maximize user safety and energy conservation. Hood shall operate on room air only with no auxiliary air supply and provide a constant sweep of air through the hood, obtained over an airfoil sill, when the sash is closed, and to maintain a constant face velocity when the sash is open at any position.

2.1.03 Verification of Fume Hood Face Velocities. With exhaust system in operation, determine the quantity of air being exhausted by measuring the velocity of the air entering the hood face, and multiplying this velocity by the square feet of hood opening. Determine the air velocity by averaging at least six velocity readings taken in the center of a grid made up of 3 sections across the top half of the hood face and 3 sections across the bottom half of the hood face. Maximum variation of readings from the average face velocity: plus-or-minus 10 fpm (3.05 m per min.).

2.1.04 Air Flow – General. When the selected face velocity has been established and verified, perform the following tests:

Make a complete traverse of the hood face with a cotton swab dipped in titanium tetrachloride to demonstrate that a positive flow of air is maintained into the hood over the entire hood face. No reverse air flow or dead air space will be permitted.

Paint a strip of titanium tetrachloride along each end and across the working surface of the hood, in a line parallel with the hood face and 6 inches (15.24 cm) back into the hood to demonstrate that no back flow of air exists at these points and that flow of smoke is directly to the rear of the hood, without swirling turbulence or reverse flow.

Discharge a smoke bomb (one half-minute size, as available from E. Vernon Hill Company) within the hood area to show the exhaust capability of the hood and its design efficiency. No reverse air flow will be permitted. Place lighted bomb in the hood area and move it to various places, checking end panels and working surface to verify that no reverse air flow exists at any point. Lower the sash to closed position to verify that a sufficient air volume is flowing through the hood work area to carry away fumes from a massive fume source. Verify that, within one minute after the smoke bomb stops discharging smoke, the hood area is purged of smoke.

Repeat the above test for every face velocity setting selected to be tested in the 70-125 fpm range (21.3 - 38.1 m per min.).

2.1.05 Sash. Provide sash which will glide smoothly and freely and hold at any height without creeping, assuring proper counter-balance.

2.2 ACCEPTABLE MANUFACTURERS. Fume hoods may be provided by Kewaunee Scientific Equipment Corp., Fisher Hamilton Scientific Inc., Labconco, Inc, or as approved.

2.3 MATERIALS. Unless otherwise specified or indicated, provide materials, construction and finishes in accordance with the manufacturers latest catalog published at time of bidding, and with approved Samples.

2.3.01 Molded Resin for Casework. Modified epoxy resin as manufactured by Epoxyn Products, Kewaunee Scientific Equipment Corp., or as approved, uniform in mixture throughout thickness, non-glaring, black color, having the following minimum properties as tested in accordance with referenced ASTM designations:

Flexural strength	15,000 psi (103,410 KPa); D790
Compressive strength	35,000 psi (241,290 KPa); D695
Tensile strength	8,500 psi (58,599 KPa); D638
Hardness, Rockewell M	100; D785
Flammability	Self extinguishing; D635
Water absorption, percent by weight, maximum in 24 hours	0.02; D570

2.3.02 Stainless Steel. Shall be per ASTM A167, Type 304, No. 4 finish, unless otherwise specified.

2.3.03 Sheet Steel. Shall be per ASTM A366 and free from scale, pits, buckles and other imperfections. Sheet steel for surfaces exposed to view: stretcher leveled.

2.3.04 Aluminum. Shall be per Extruded aluminum, ASTM B221, alloy 6063-T42 or 6063-T5.

2.3.05 Glass. Shall be per ASTM C1036, glass for framed doors.

Safety glass for metal fume hoods: sheets of float glass separated by clear plastic interlayer.

2.3.06 Sealant. Shall be two-component epoxy compound.

2.3.07 Table Leg Shoes. 2 1/2 inch (6.35 cm) high vinyl with bottom coved, color to match base selected by the Engineer for the room finish.

2.3.08 Fixture Materials. Chromium-plating: an electro-deposited copper-nickel-chromium coating. Minimum thickness of chromium: 0.000015 inch (.0000381 cm).

Leaded red brass castings Shall be per ASTM B584.

2.3.09 White Polyresin. White polyresin shall be per as manufactured by Fisher Hamilton Scientific Inc, or as approved with uniform color throughout.

Material consists of a press-molded, that converted catalyzed glass polyester sheet which is flame retardant, self extinguishing.

2.4 CONSTRUCTION. Provide fume hood superstructure of double wall construction with a flush interior lining and a removable interior baffle with adjustable openings at top and bottom, or at top, bottom and middle. Fabricate screws and other metal exposed on interior, except service fixtures, of stainless steel. Fabricate exterior of sheet steel.

Provide interior light fixture, UL-listed, two-lamp fluorescent, 120-volt, unless otherwise specified, shielded from hood interior by safety glass or tempered glass sealed to hood and provided with access panel.

Fabricate sliding sash of 18 gage (1.3 mm) steel or stainless steel sheet frame with corners overlapped and welded or mitered and welded and ground smooth, glazed with safety glass set with rubber channel and stainless steel inside stop screwed on. Provide vertical sliding sash suspended on stainless steel cables over ball bearing sheaves, counterbalanced to insure non-binding sash performance and fitted with chromium-plated pull handles or integral, full-width, flush pull. Provide single-hung sashes, except at 8 foot (2.4 m) hoods, which shall have two equally dependent interlocking operation vertical full view sashes so that each can be opened only when the other sash is fully closed. Sashes to ride in PVC or stainless steel guides. Provide access to counterweight system for maintenance.

Provide sash stops at 18 inches (45.72 cm) above the working surface.

Fabricate duct collar at top of hood of terne plate with plastic metallic aluminum finish or stainless steel.

Mount an air foil at bottom of hood opening, with approximately a one-inch open space between the foil and top front edge of working surface, extending back under sash so that sash closes on top of the foil.

Provide all operable components, work surfaces, fixture locations and clearances at Fume Hoods indicated as ADA compliant to comply with ANSI CABO A117.1.

2.4.01 Casework Materials. Provide casework, including cabinets and countertops, which is the product of one of the manufacturers specified for each type of casework.

Provide materials, construction and finishes in accordance with the manufacturer's latest catalog published at time of bidding and with approved Samples.

Include sinks, fixtures, and fittings. All fixtures shall be by one manufacturer.

Construct metal cabinets of sheet steel with minimum thickness (U.S. standard gage) as follows:

Corner gussets for leveling blots and apron corner braces	12 gage (.2754 cm)
Drawer support channels	14 gage (.1994 cm)
Hinge reinforcement	14 gage (.1994 cm)
Horizontal rails, and reinforcing gussets	16 gage (.1613 cm)
Aprons	16 gage (.1613 cm)
Support struts	16 gage (.1613 cm)
Cabinet tops, ends, bottom, backs, vertical posts, shelves, glazed doors	18 gage (.1311 cm)
Door panels, scribing strips, filler	20 gage (.1006 cm)

panels, enclosures, drawer fronts
and bodies

2.4.02 Cabinet Construction. Provide cabinets of modular construction so that the various units can be combined in assemblies to fit the floor plan and functional requirements of the facility.

Cabinets construction shall be durable, sturdy, dust-tight and designed to provide easy access for installation and maintenance of plumbing and electrical work.

Shut-off valves and plumbing traps in service chase assemblies shall be accessible with cabinets in place. Coordinate access panel requirements with plumbing work.

Drawers operation shall be smooth and quiet for a minimum of 10,000 in-out cycles with a 150 lb. (67.95 Kg) Load evenly distributed in drawer.

Self-centering full width drawers in 3 foot (.91 m) and 4 foot (1.21 m) wide cabinets shall be operable from corner without racking or binding when loaded or empty.

Maximum force required to open a drawer shall be 3 percent of unloaded or loaded drawer weight.

Drawer shall be full drawer extension type.

Doors shall support, without sagging, a 200 lb. (90.60 Kg) load applied at top edge while door is being swung up to 180 degrees.

Provide closure panels to enclose space between ceiling and fume hoods. Provide fillers between wall and cabinets and between cabinets and fume hoods.
Filler panels between metal cabinets and wall or between metal cabinets and fume hoods shall be metal and finished to match metal cabinets. Closure panels shall be fabricated of sheet steel and channel-shaped.

2.5 CONTROLS.

2.5.01 Control System Components. Install the operator control panel and the volume flow control device, specified herein, for each variable air volume hood, under the supervision of the laboratory hood control systems manufacturers' field engineer.

2.6 MANUFACTURE AND FABRICATION.

2.6.01 General Purpose Interior Construction. Lining and baffle shall be white polyresin material, with joints in lining backed up and sealed.

Working surface shall be 1-1/4 inch (3.17 cm) thick molded resin with 1/2 inch (1.27 cm) depression.

Provide molded resin cup sink fitted with sink plug for general purpose superstructures to be mounted on base cabinets. Sink plug shall be molded resin, 1-1/2 inch (3.81 cm), with integral cross bars, removable strainer, inlet machined for overflow, threaded tailpiece, complete with washer and lock nut.

2.6.02 Finish for Sheet Steel. After fabrication and before finishing, thoroughly clean and treat all sheet steel to prevent corrosion and to provide proper adhesion of the finish.

Apply a prime coat baked on, sand smooth, and apply a synthetic enamel or resin base finish system baked on.

For surfaces exposed to view on exterior of hood, comply with performance requirements for moisture and chemical resistance.

Finished surfaces with smooth, semi-matte finish, evenly covered without short or thin coating on corners, runs, sags, or roughness.

Color shall be as selected by the Engineer from manufacturer's standard range.

2.7 GENERAL PURPOSE HOOD. Use conventional type hood with variable air volume

2.7.01 Construction. Metal fume hood shall be used with general purpose interior construction. Sidewalls of superstructure for general purpose hood with approximately 3-1/2 inches (8.89 cm) thick and contain the mechanical and electrical service fixtures.

2.8 SERVICE FIXTURES.

2.8.01 General Mechanical Fixtures. Include piping from valves to outlets, mounted in fume hoods. All renewable valve components to be serviceable from outside of hood.

Remote-controlled with four-arm control handles. Fixture surfaces exposed on interior of hood coated with an acid-and-solvent-resistant finish baked on to minimum dry film thickness of 2 mils.

2.8.02 Water. Fixed gooseneck type with renewable units containing all working parts including a model or stainless steel replaceable seat. Provide an integral volume control contained in the renewable unit or in the inlet or outlet of the fixture.

2.8.03 Air, gas and vacuum. Provide a stainless steel floating needle and removable stainless steel seat for air valves. Action of valve shall be slow compression for fine control under pressures up to 100 psi (689.4 KPA).

2.8.04 Acetylene Fixtures. Provide units with a self-centering stainless steel floating cone and replaceable stainless steel seat.

Provide turret base for deck mounting. At island assemblies, provide set of two cocks at 180 degrees. For all other deck mounted fixtures, provide one cock.

2.8.05 Electrical Fixtures. Pre-wire electrical equipment in fume hood to a junction box mounted on top of hood.

In addition to specified light fixtures, provide the following for each fume hood, unless otherwise indicated: 2 duplex receptacles, 1 light switch and wiring devices as specified in Master Specification Section 16050, Electrical.

2.9 FUME HOOD CONTROLS.

2.9.01 Manufactured Units. Provide the laboratory airflow control systems to control the airflow into and out of the laboratory rooms and laboratory auxiliary support rooms where indicated on the drawings. The exhaust volume of a laboratory fume hood is to be controlled by a fume hood control system to maintain a constant average face velocity into the fume hood. A make-up/supply air control system varies the volume of supply and make-up air into room to maintain both temperature control and airflow balance (e.g. room pressurization).

This system includes fume hood control systems, make-up/supply air controllers, supply, exhaust, constant volume and general purpose airflow terminal units, plus all interconnecting wiring and pneumatic tubing to result in a complete and operational system.

Provide all control components except for pneumatic actuators to be DDC analog electronic in nature.

Provide controls manufactured by Phoenix Controls; ACCU-Aire Controls, Inc.; Tek-Air Systems, Inc.; Siemens Building Technologies, Landis Division; TSI, Inc., or approved equal.

Designed and installed in strict compliance with the NFPA 70 requirements. All electric and electronic devices installed within hoods, exhaust ductwork, or exposed to the fume hood environment, listed under UL 913.

2.9.02 Fume Hood Monitor and Controller. Fume hood monitor and controller directly measures the area of the fume hood sash opening. The fume hood monitor and controller use the measured sash opening to proportionally control the hood's exhaust airflow. Hood airflow is varied to maintain an "average" constant face velocity to +/- 5% tolerance over no less than a 5 to 1 change in the sash open area.

The fume hood control system responds to a step change in sash position by reaching 90 degrees of the final position CFM value within one (1) second with no more than a 5 degrees overshoot or undershoot and with no noticeable oscillation.

A vertical sash sensor measures the height of each vertically moving fume hood sash. Install the sash sensor in an easily accessible location on the fume hood for service.

Provide a horizontal sash sensor for each pair of horizontal or overlapping sashes that are located on horizontal, combination or walk-in sash fume hoods. The horizontal sash sensors determine the total amount of horizontal sash opening. The sash sensors must not obstruct hood usage.

Provide the required combinations of vertical and/or horizontal sash sensors as required by the types of fume hoods to be controlled.

The fume hood monitor receives the sash opening signals from the vertical and/or horizontal sash sensors. The monitor computes the total open sash area and then outputs an exhaust airflow control command signal to the appropriate exhaust airflow control device.

An emergency exhaust capability to override the sash sensor and command maximum exhaust airflow. A push button switch shall initiate this mode.

The fume hood monitor is to include visual indication for normal operation, visual and audible alarm for an unsafe flow condition and visual and audible alarm to indicate emergency exhaust condition. Alarms automatically reset when the alarm condition ceases.

Provide a push button switch to mute the audible alarm. The mute mode automatically resets when the alarm condition ceases.

The fume hood monitor alarms an unsafe flow condition if any of the following conditions occur: The airflow through the hood reduces to approximately 25 percent below its setpoint, or the hood exhaust airflow terminal unit does not move to its commanded position.

2.9.03 Laboratory Air Terminal Units. Laboratory air terminal unit controls the exhaust flow out of a fume hood, the general exhaust or return airflow out of a room, or make-up/supply airflow into a room.

All terminal units are to have an equal percentage flow characteristic to provide stable control at low flow values.

Terminal unit is to be pressure independent throughout a pressure drop range of 0.6” WG to 3.0” WG (static pressure drop across the terminal unit). The terminal unit is to respond and maintain specific airflow within one (1) second of a change in duct static pressure, irrespective of the magnitude of the pressure change (within the above stated pressure drop range) and irrespective of the quantity of terminal units on a manifold system.

Terminal unit airflow control accuracy is to be +/- 5% of reading regardless of duct inlet or exit configurations over turndown range of no less than 16 to 1.

Laboratory airflow control system is to maintain intersystem stability within one (1) second of a change in duct static pressure and/or flow to eliminate hunting, system oscillations and crosstalk between airflow controllers.

Fume hood exhaust terminal units shall be of a corrosion resistant design. All components and/or surfaces exposed to the airstream shall be 316 stainless steel, or shall have at least two baked-on coats of Heresite P403 coating material.

Electronically Modulated Laboratory Airflow Terminal Units shall be able to vary the terminal unit’s airflow to within 90% of its commanded setpoint value is to be no more than one (1) second less than a 5% undershoot or overshoot.

A pneumatic actuator to the terminal unit body to vary the terminal unit from its minimum to maximum flows. Loss of pneumatic supply air causes the terminal units to fail to the position indicated on the drawings. Fail-in-last-position actuators, electric actuators or actuators which fail to uncontrolled flows are not acceptable.

2.9.04 Control Unit. Provide a Control Unit (CU) to control the supply and/or general exhaust airflow control devices to maintain proper room pressurized polarity (positive or negative). Each individual laboratory with fume hoods shall have a dedicated CU. Provide a microprocessor-based digital controller.

The CU maintains a constant design offset between the sum of the room’s total exhaust and make-up/supply airflows. This offset is to be field adjustable and represents the volume of air which will enter (or exit) the room from the corridor or adjacent spaces.

All points shall be available through an interface to the building management system (BMS) for trending, archiving, graphics alarm notification and status reports. Laboratory airflow control system performance (speed, stability and accuracy) must be unaffected by the quantity of points being monitored, processed, or controlled.

Refer to the BMS specification to the required input/output summary for the necessary points to be monitored and/or controlled.

Provide the CU with the capability for full stand alone operation as well as capable of communicating digitally with other CUs.

Provide the CU with a port connecting a notebook computer, desktop computer, modem, or alarm printer. This port provides access to all points in the CU.

The CU is to meet FCC Part Subpart L Class A, and be UL 916 listed.

2.10 CABINET HARDWARE.

2.10.01 General. Catches, shelf adjustment clips and drawer stops shall be cadmium-or nickel-plated steel and sliding doors with nylon rollers.

2.10.02 Pulls. Drawer pulls and pulls for swing doors shall be brass or cast zinc alloy with dull chromium-plated finish, or extruded aluminum with clear polished anodic finish. Provide two pulls on drawers wider than 28 inches (71.12 cm). Pulls for sliding doors shall be recessed flush with door.

2.10.03 Hinges. Chromium-plated brass or steel, 2 1/2 inch (6.35 cm) heavy duty institutional type, attached with flathead screws. For doors over 36 inches (91.44) high, provide 1 1/2 pair of hinges.

2.10.04 Keying. Unless otherwise directed, key locks alike within a room, differently between rooms and masterkey all locks.

2.11 COUNTERTOPS.

2.11.01 General. Provide countertops and backsplashes of the same material up to and including 8 feet (2.43 m) in length in one length. Where countertops exceed 8 feet (2.43) in length, provide concealed field joints of flush-bolt construction or other approved construction. Provide cutouts for required service fixtures and sinks.

2.11.02 Molded Resin Tops. One inch thick top with 4 inch (10.16 cm) high and 3/4 inch (1.91 cm) thick integral curb. Provide drip groove at underside of exposed edges and round exposed corners. Cove junction between top and curb to a 3/4 inch (1.91 cm) radius.

Curbs at sides of tops shall be 3/4 inch (1.91cm) thick, bonded to the surface of top to form a square joint.

2.11.03 Stainless Steel Tops. Fabricated tops of 16 gage (.1613 cm) stainless steel. Exposed edges shall be formed into channel shape. Edge of top shall be 1 inch (2.54 cm) plus raised rim for tops with sinks. Underside reinforced shall be constructed to prevent twisting, oil canning or buckling and coated with sound deadner.

Backsplashes, curbs and integral sinks shall be in one piece with top or continuously welded to top, welds ground smooth and welding flash removed. Provide drainboard adjacent to sinks. No field joints, or no organic materials will be accepted.

Strippable plastic coating shall be provided on finished surfaces for protection.

2.12 SERVICE CHASE ASSEMBLIES.

2.12.01 General. Provide horizontal service chase assemblies, and vertical pipe enclosures as directed.

2.12.02 Service Chase Assembly. Horizontal pipe support strut assembly shall be fabricated from steel components and secured to floor. Removable closure panels of same material and finish as cabinets shall also be provided.

2.12.03 Vertical Pipe Enclosures. A vertical pipe support strut assembly shall be fabricated from steel components and secured to counter top, masonry wall or floor with removable metal closure panels.

2.13 SINKS.

2.13.01 Manufacturers. Molded resin sinks shall be Epoxyn Products, or as approved.

2.13.02 Molded Resin Sink. Use one-piece construction with all inside corners coved and bottom pitched to drain outlet. Fit sink with molded resin sink plug 1 1/2 inches (3,81 cm) with integral cross bars, removable strainer, inlet machined for overflow, and threaded tailpiece, complete with washer and locknut. Provide proper hanger support for sink.

2.13.03 Stainless Steel Sinks. Use 18 gauge (.1311 cm), unless otherwise specified, integral top, welded joints, ground smooth, polished, inside corners coved and bottom pitched shall drain to outlet. Provide sound-deadner spray applied to underside of sinks.

Sinks more than 10 inches (25.4 cm) deep or more than 96 inches (243.84 cm) in perimeter shall be 16 gage (.1613 cm).

Fit each stainless steel sink with a stainless steel sink plug, integral cross bars, removable strainer, inlet tapered for overflow, and 16 gage (.1613 cm) threaded tailpiece, complete with washer and locknut.

2.14 GLASSWARE WASHERS. Furnish a Reliance Glassware Washer, Model 370 or equal. Voltage shall be 208 V, 3-PH, 60 Hz, 4-Wire. Options include cold water pre-wash, pure water rinse, second pure water rinse, and electric water temperature booster. Under-counter installation to include closure and filler panels to surrounding work to completely enclose space below counter. Closure and filler panels to be the same material and finish as glassware washer and glassware dryer enclosures.

2.15 GLASSWARE DRYER. Furnish a Reliance Glassware Dryer, Model 375 or equal. Voltage shall be 208 V, 3-Phase, 60 Hz, 4-Wire. Options include adjustable digital cycle timer and adjustable temperature controller. Under-counter installation to include closure and filler panels to surrounding work to completely enclose space below counter. Closure and filler panels to be the same material and finish as glassware dryer and glassware washer enclosures.

2.16 STERILIZER. Furnish an Amsco Century Small Sterilizer or equal. Size/Type shall be 16 x 16 x 26 vacuum. Steam source shall be electric steam, 480 Volts. Doors shall be single mounted so cabinet will be enclosed/freestanding. Options include electric stainless steel steam generator, eighteen cycle capacity (six per screen). Accessories include single door, one intermediate shelf, and single door.

PART 3 - EXECUTION

3.1 PREPARATION. Protect the Work and adjacent construction from damage during installation and subsequent operations under the Contract.

3.2 INSTALLATION.

3.2.01 General. Install casework and fume hoods in accordance with manufacturer's instructions and approved Shop Drawings, and under the supervision of the manufacturer's trained personnel.

3.2.02 Casework. Completely install casework less installation of mechanical and electrical service fixtures and final connection to services.

Installation of service fixtures and final connection to services are specified in Master Specification Divisions 15 and 16, Mechanical and Electrical.

3.2.03 Casework Assemblies. Assemble cabinets in the field with provision for future relocation, connected together with concealed bolts and set level and in alignment.

Install leg shoe on each table leg. Provide all fastening devices, supports, adhesive and fillers required for a complete installation. Provide metal grounds bolted to stud partitions for support of wall cabinets. Provide hanger supports for sinks with bolts and expansion shields for items connected to masonry walls.

Provide strut assemblies for support of fume hood superstructures or other heavy equipment and for drain troughs and piping. Closure panels to ceiling shall have exposed ends closed. Fillers are required to enclose space between walls and cabinets.

Provide holes and cutout required for installation of equipment indicated to be mounted to casework, including items furnished under other Sections and items indicated to be not included in the Contract. Coordinate location of utilities.

3.2.04 Countertops and Sinks. Anchor tops to base cabinet (or support structure) and knee space assemblies with concealed fastenings. Install drain troughs and sinks and sealant required to seal against tops.

Installation of sink fittings is specified in Master Specification Division 15, Mechanical. Install sink plugs and fill annular space around top of sink plugs with sealant. Set backsplashes and curbs in a full bed of sealant. Seal joints in tops, backsplashes and cubs with sealant.

3.2.05 Fume Hoods. Install the Work completely less final connection to mechanical and electrical services, and in accordance with manufacturer's instructions and approved Shop Drawings and under the supervision of the manufacturer's representative.

Touch up damaged finishes equal to original condition as approved. Make final adjustments required for proper operation as determined by the Contractor.

Require the laboratory hood control system manufacturer to be responsible for ensuring that the hood control system is installed and operates properly, and to provide a field engineer to supervise the installation of all components. Deliver the laboratory hood control system devices connected to, or installed within laboratory hoods, to the laboratory hood manufacturer for installation.

Exhaust Control Devices shall provide detailed installation instructions for such devices prior to installation. Check all dampers for proper positioning and assure that linkages are properly set and operating.

3.3 ADJUSTING. Make final adjustment required for proper operation as determined by the Engineer

3.4 CLEANING. Following completion, clean finished surfaces and leave work free of imperfections. Touch up damaged finish equal to original condition as approved.

End of Section

SECTION 12800

UTILITY ROOM FURNISHINGS

PART 1 - GENERAL

1.1 SCOPE. This section covers miscellaneous utility room furnishings and accessories.

1.2 GENERAL.

1.2.01 Governing Standards.

ASTM (American Society for Testing and Materials) D635 – Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

National Fire Protection Association (NFPA) 70 – Specification for National Electrical Code

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturers Qualifications. Manufacturers shall have not less than 5 years documented experience in manufacture of a furnishings specified.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit layout drawings showing proposed locations of items specified and applicable details of fabrication and installation. Submit data showing dimensions of individual components, profiles and finishes, utility and service requirements and locations.

1.4.02 Samples. Submit samples of finishes for color selection.

Submit operation and maintenance data for cleaning of finishes.

1.5 RECEIVING, HANDLING AND STORAGE. Handle and store materials carefully. Protect products from weather and other damage.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Furnish products from American Specialties, Inc., Kohler, Bradley Corp. or an approved equal. Unless otherwise specified or indicated, provide materials, construction and finishes in accordance with the manufacturer's latest catalog published at time of bidding, and with approved Samples.

2.2 MEDICINE CABINET. One-piece construction of heavy-gage steel with factory-applied, gloss white, baked enamel finish, surface-mounted. Furnish with bright polished finish stainless steel mirror frame, type as indicated on the drawings.

Shelves: Adjustable, aluminum or glass; provide not less than 2 shelves.

Door: Fitted with continuous piano-type hinge, magnetized catch, left-hand swing.

2.3 SERVICE SINK. Provide a raised floor utility service sink where indicated on the drawings. Manufactured sinks may be provided to the sizes indicated from the manufacturers listed above or an approved equal. Materials shall be as indicated on the drawings. Where permitted, a precast concrete or terrazzo service sink may be provided.

2.3.01 Faucet. Provide brass service sink faucet by Kohler Model K-8905 or an approved equal.

2.4 UTILITY ROOM ACCESSORIES.

2.4.01 Mop and Broom Holder. Provide holders as indicated on the drawings of 0.05 inch (1.3 mm) thick stainless steel, Type 304 with hat-shaped channel.

Holders: 3 spring-loaded rubber cam holders.

Length: 36 inches (914 mm).

Length: Manufacturer’s standard length for number of holders.

2.4.02 Combination Utility Shelf/Mop and Broom Holder. Provided combination holders as indicated on the drawings of 0.05 inch (1.3 mm) thick stainless steel, Type 304, with ½ inch (12 mm) returned edges, 0.06 inch (1.6 mm) steel wall brackets.

Drying rod: Stainless steel, ¼ inch (6 mm) diameter.

Hooks: 3, 0.06 inch (1.6 mm) stainless steel rag hooks at shelf front.

Mop/broom holders: 3 spring-loaded rubber cam holders at shelf front.

Length: 36 inches (914 mm).

Length: Manufacturer’s standard length for number of holders/hooks.

PART 3 - EXECUTION

3.1 INSPECTION. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

Confirm that millwork is constructed with minimum sizes indicated for particular fixtures.

3.2 PREPARATION. Protect the Work and adjacent construction against damage. Rough-in fixture piping connection shall be in accordance with minimum sizes indicated for particular fixtures.

3.3 INSTALLATION. Install the Work in accordance with manufacturer's instructions and approved Shop Drawings.

Touch up damaged finishes equal to original condition as approved.

End of Section

INDEX

DIVISION 13 – SPECIAL CONSTRUCTION

SECTION 13110

CATHODIC PROTECTION SYSTEM (SACRIFICIAL ANODE)

PART 1 – GENERAL

1.1 SCOPE. This specification covers system for cathodically protecting metal buried surfaces against corrosion by producing a continuous flow of direct current from sacrificial anodes to the metal to be protected. The anodes shall be of sufficient size and quantity to protect the buried metal items for a specified number of years before replacement.

1.2 GENERAL.

1.2.01 Governing Standards. The current editions of publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only

ASTM (American Society For Testing and Materials) B 418 - Cast and Wrought Galvanic Zinc Anodes.

ASTM B 843 – Magnesium Alloy Anodes for Cathodic Protection.

ASTM D 1248 – Polyethylene Plastics Molding and Extrusion Materials.

CFR (Code of Federal Regulations) 40 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST).

49 CFR 192 Transportation of Natural and other Gas by Pipeline: Minimum Federal Safety Standards.

49 CFR 195 Transportation of Hazardous Liquids by Pipeline.

NACE (National Association of Corrosion Engineers) RP0169 - Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

NACE RP0177 – Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems.

NACE RP0188 – Discontinuity (Holiday) Testing of Protective Coatings.

NACE RP0190 - External Protective Coatings for Joints, Fittings, and Valves on Metallic Underground or Submerged Pipelines and Piping Systems.

NACE RP0193 - External Cathodic Protection of On-Grade Metallic Storage Tank Bottoms.

NACE RP0285 - Corrosion Control of Underground Storage Tank Systems by Cathodic Protection.

NEMA (National Electrical Manufacturers Association) TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80).

NEMA WC 5 -Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

NFPA (National Fire Protection Association) 70 - National Electrical Code.

UL (Underwriters Laboratories) 6 - Rigid Metal Conduit.

UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

UL 514A - Metallic Outlet Boxes.

1.3 QUALITY ASSURANCE.

1.3.01 Services of “Corrosion Expert”. The Contractor shall obtain the services of a “Corrosion Expert” to supervise, inspect, and test the installation and performance of the cathodic protection system. “Corrosion Expert” refers to a person, who by thorough knowledge of the physical sciences and the principles of engineering and mathematics, acquired by professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic surfaces. Such a person shall be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified Cathodic Protection (CP) Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping and tank systems, if such certification or licensing includes 5 years experience in corrosion control on underground metallic surfaces of the type under this contract.

The “Corrosion Expert” shall make at least 3 visits to the project site. The first of these visits shall include obtaining soil resistivity data, acknowledging the type of pipeline coatings to be used and reporting to the Contractor the type of cathodic protection required. Once the submittals are approved and the materials delivered, the “Corrosion Expert” shall revisit the site to ensure that the Contractor understands installation practices and laying out the components. The third visit shall involve testing the installed cathodic protection systems and training applicable personnel on proper maintenance techniques. The “Corrosion Expert” shall supervise installation and testing of all cathodic protection.

The scope of services provided by the “Corrosion Expert” shall include, but shall not be limited to, the following:

Close-interval potential surveys

Design of Cathodic Protection Systems

System testing

Casing corrosion control

Interference testing

Training

Operating and maintenance manual

Insulator testing and bonding testing

Coating and holiday testing procedures shall be submitted within 45 days of notice to proceed

1.3.02 Electrical Potential Measurements. Electrical potential tests shall be made at a minimum of 10 foot (3 m) intervals witnessed by the Engineer. Submittals shall identify test locations on separate drawing, showing all metal to be protected and all cathodic protection equipment. Test points equipment and protected metal shall be easily distinguished and identified, and shall be properly witnessed.

1.3.03 Tests of Components. A minimum of 4 tests shall be made at each metallic component. Two measurements shall be made directly over the anodes and the other 2 tests shall be over the outer edge of the component, but at the farthest point from the anodes. Structure and pipes shall be shown with the cathodic protection equipment. All components of the cathodic protection system shall be shown on drawings, showing their relationship to the protected structure or component. A narrative shall describe how the cathodic protection system will work and provide testing at each component. Components requiring cathodic protection shall include but not be limited to the following:

Pipes under floor slabs or foundations.

Shutoff valves.

Metallic pipe extended from aboveground locations.

Each connector or change-of-direction device.

Any metallic pipe component or section.

Backflow preventor.

Culvert.

Underground metallic storage tanks.

1.3.04 Achievement of Criteria for Protection. All conductors, unless otherwise shown, shall be routed to or through the test stations. Each system provided shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolt potential with reference to a saturated copper-copper-sulfate reference cell on all underground components of the piping system. Based upon the measurements taken, the current and voltage of the anodes shall be adjusted as required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area. This must be achieved without the "instant off" potential exceeding 1150 millivolts. Testing will be witnessed by the Engineer. Additional anodes shall be provided by the Contractor if required to achieve the minus 850 millivolts "instant off". Although acceptance criteria of the cathodic protection systems are defined in NACE RP0169 , for this project the "instant off" potential of minus 850 millivolts is the only acceptable criteria.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit detailed drawings. Provide a complete list of equipment and material including manufacturer's descriptive and technical literature, catalog cuts, and system design calculations. Provide soil-resistivity and certified test data stating the maximum recommended anode current output density and the rate of gaseous production if any at that current density. Detail drawings shall contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will function properly as a unit. The drawings shall show anode arrangement, anode size and number, anode materials and layout details, conduit size, wire size, mounting details, wiring diagram, method for electrically-isolating each pipe, and any other pertinent information required for proper installation and performance of the system.

Within 30 days after receipt of notice to proceed, submit an itemized list of equipment and materials to be furnished including item number, quantity, and manufacturer of each item. The list shall be accompanied by a description of procedures for each type of testing and adjustments, including testing of coating for thickness and holidays. Installation of materials and equipment shall not commence until this submittal is approved.

Submit recommended spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts, special tools, and supplies, with current unit prices and source of supply. One spare anode of each type shall be furnished.

The Contractor shall prepare a report that includes pipe-to-soil measurements throughout the affected area, indicating that the modifications improved the overall conditions, and current measurements for anodes. The following special materials and information are required: taping materials and conductors; zinc grounding cell, installation and testing procedures, and equipment; coating material; system design calculations for anode number, life, and parameters to achieve protective potential; backfill shield material and installation details showing waterproofing; bonding and waterproofing details; insulated resistance wire; exothermic weld equipment and material.

1.4.02 Certification. Submit proof that the materials and equipment furnished under this section conform to the specified requirements contained in the referenced standards or publications. The label or listing by the specified agency will be acceptable evidence of such compliance.

The "Corrosion Expert's" name and qualifications shall be certified in writing to the Engineer prior to the start of construction. Certification shall be submitted giving the name of the firm, the number of years of experience, and a list of not less than 5 of the firm's installations 3 or more years old that have been tested and found satisfactory.

1.4.03 Test Reports. Submit test reports in booklet form tabulating all field tests and measurements performed, upon completion and testing of the installed system and including close interval potential survey, casing and interference tests, final system test verifying protection, insulated joint and bond tests, and holiday coating test. A certified test report showing that the connecting method has passed a 120-day laboratory test without failure at the place of connection, wherein the anode is subjected to maximum recommended current output while immersed in a three percent sodium chloride solution.

1.4.04 Record Drawings. Detailed “as-built” record drawings shall be provided showing location of anodes, insulated fittings, test stations, permanent reference cells, and bonding. Each location shall be referenced to 2 permanent facilities or mark points.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Anode Storage. The Engineer will designate storage area for magnesium anodes. If anodes are not stored in a building, tarps or similar protection shall be used to protect anodes from inclement weather. Packaged anodes, damaged as a result of improper handling or being exposed to rain, shall be re-sacked by the Contractor and the required backfill added to the package.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The Contractor shall furnish and install a complete, operating, sacrificial anode cathodic protection system in complete compliance with NFPA 70, with all applicable Federal, State, and local regulations and with minimum requirements of this contract. The services required include planning, installation, adjusting and testing of a cathodic protection system, using sacrificial anodes for cathodic protection of the designated buried metallic tanks and pipelines. The cathodic protection system shall include anodes, cables, connectors, corrosion protection test stations, and any other equipment required for a complete operating system providing the NACE criteria of protection as specified. Insulators are required whenever needed to insulate the pipes from any other structure. Any pipe crossing a designated buried pipe shall have a test station.

The specified system shall be based on a complete system with magnesium sacrificial anodes. The Contractor shall modify the cathodic protection system after review of the project, site verification, and analysis, if the proposed modifications include the anodes specified and will provide better overall system performance. The modifications shall be fully described, shall be approved by the Engineer's representative, and shall meet the following criteria.

The proposed system shall achieve a minimum pipe-to-soil "instant off" potential of minus 850 millivolts with reference to a saturated copper-copper sulfate reference cell on the underground components of the piping or other metallic surface. The Contractor shall take resistivity measurements of the soil in the vicinity of the pipes and ground bed sites. Based upon the measurements taken, the current and voltage shall be required to produce a minimum of minus 850 millivolts "instant off" potential between the structure being tested and the reference cell. This potential shall be obtained over 95 percent of the metallic area.

The anode system shall be designed for a life of 25 years of continuous operation.

2.1.01 Isolators. Isolators are required to insulate the indicated pipes from any other structure. Isolators shall be provided with lightning protection and a test station as shown.

2.1.02 Anode and Bond Wires. Magnesium anodes shall be provided at uniform distances along the metallic pipelines. These anodes shall be in addition to anodes for the pipe under concrete slab and casing requirements. For each cathodic system, the metallic components and structures to be protected shall be made electrically continuous. This shall be accomplished by installing bond wires between the various structures. Bonding of existing buried structures may also be required to preclude detrimental stray current effects and safety hazards. Provisions shall be included to return stray current to its source without damaging structures intercepting the stray current. The electrical isolation of underground facilities in accordance with acceptable industry practice shall be included under this section. The Engineer shall witness all tests.

2.1.03 Surge Protection. Approved zinc grounding cells or sealed weatherproof lightning arrestor devices shall be installed across insulated flanges or fittings installed in underground piping as indicated on the drawings. The arrestor shall be gapless, self-healing, solid state type. Zinc anode composition shall conform to ASTM B 418, Type II. Lead wires shall be number 6 AWG copper with high molecular weight polyethylene (HMWPE) insulation. The zinc grounding cells shall not be prepackaged in backfill but shall be installed as detailed on the drawings. Lightning arrestors or zinc grounding cells are not required for insulated flanges on metallic components used on nonmetallic piping systems.

2.1.04 Nonmetallic Pipe System. In the event pipe other than metallic pipe is approved and used in lieu of metallic pipe, all metallic components of this pipe system shall be protected with cathodic protection. Detailed drawings of cathodic protection for each component shall be submitted to the Engineer for approval within 45 days after date of receipt of notice to proceed, and before commencement of any work.

2.1.05 Tracer Wire. When a nonmetallic pipe line is used to extend or add to an existing metallic line, an insulated No. 8 AWG copper wire shall be thermit-welded to the existing metallic line and run the length of the new nonmetallic line. This wire shall be used as a locator tracer wire and to maintain continuity to any future extensions of the pipeline.

2.1.06 Coatings. Coatings for metallic components shall be as required for metallic fittings. Protective covering (coating and taping) shall be completed and tested on each metallic component (such as valves, hydrants and fittings). This includes fire hydrants, T's, elbows, valves, etc. This covering shall be as required for underground metallic pipe. The Engineer shall witness each test. Coatings shall be selected, applied, and inspected in accordance with NACE RP0190 and as specified in these specifications. The use of nonmetallic pipe does not change other requirements of the specifications. Any deviations due to the use of nonmetallic pipe shall be submitted for approval.

2.1.07 Metallic Components. As a minimum, each metallic component shall be protected with 2 magnesium anodes. This number of anodes is required to achieve minus 850 millivolts "instant off" potential on the metallic area and at the same time not provide overvoltage above 1150 millivolts "instant off. The magnesium anodes shall be located on each side of the metallic component and routed through a test station.

2.1.08 Fire Hydrants. Fire hydrant pipe components shall have a minimum of two (2) anodes. These magnesium anodes shall have an unpackaged weight of 17 lbs. (7.7 kg).

2.1.09 Pipe Under Concrete Slab. Pipe under concrete slabs shall have a minimum of 2 magnesium anodes. Pipe under concrete slabs shall have a minimum of 2 permanent reference electrodes located under the slab. One permanent reference electrode shall be located where the pipe enters the concrete slab. All conductors shall be routed to a test station.

2.1.10 Valves. Each valve shall be protected with a minimum of 1 magnesium anode.

2.1.11 Metallic Pipe Component or Section. Each section of metallic pipe shall be protected with a minimum of 2 magnesium anodes.

2.1.12 Connectors or Change-of-Direction Devices: Each change-of-direction device shall be protected with a minimum of 2 magnesium anodes.

2.2 MATERIALS.

2.2.01 Magnesium Anodes. Anodes shall be of high-potential magnesium alloy, made of primary magnesium obtained from seawater or brine, and not made from scrap metal. Magnesium anodes shall conform to ASTM B 843 and to the following analysis (in percents) unless otherwise indicated: Aluminum max. 0.010; Manganese max. 0.50 to 1.30; Zinc 0.05; Silicon max. 0.05; Copper max. 0.02; Nickel max. 0.001; Iron Max. 0.03; Other impurities max. 0.05 each or 0.3 max. The Contractor shall furnish spectrographic analysis on samples from each heat or batch of anodes used on this project.

Refer to the Cathodic Protection Schedule for actual quantities and weights of anodes. A minimum of 2 anodes shall be installed on the pipe system. The tables below show typical dimensions for given weights of anodes.

TYPICAL MAGNESIUM ANODE SIZE (English Units)
(Cross sections may be round, square, or D shaped)

NOMINAL WT. (lbs)	APPROX SIZE (in)	NOMINAL GROSS WT (lb) PACKAGED IN BACKFILL	NOMINAL PACKAGE DIMENSIONS (in)
3	3 X 3 X 5	8	5-1/4 X 5-1/4 X 8
5	3 X 3 X 8	13	5-1/4 X 5-1/4 X 11-1/4
9	3 X 3 X 14	27	5-1/4 X 20
12	4 X 4 X 12	32	7-1/2 X 18
17	4 X 4 X 17	45	7-1/2 X 24
32	5 X 5 X 20-1/2	68	8-1/2 X 28
50	7 X 7 X 16	100	10 X 24

(Note: Multiply lbs. by 2.2 for Kg and Multiply in. by 2.54 for cm)
TYPICAL MAGNESIUM ANODE SIZE (Metric Units)
(Cross sections may be round, square, or D shaped)

NOMINAL WT (kg)	APPROX SIZE (mm)	NOMINAL GROSS WT (kg) PACKAGED IN BACKFILL	NOMINAL PACKAGE DIMENSIONS (mm)
1.4	76 X 76 X 127	3.6	133 X 133 X 203
2.3	76 X 76 X 203	5.9	133 X 133 X 286
4.1	76 X 76 X 356	12.3	133 X 508
5.5	102 X 102 X 305	14.5	191 X 457
7.7	102 X 102 X 432	20.5	191 X 610
14.5	127 X 127 X 521	30.9	216 X 711
22.7	178 X 178 X 406	45.5	254 X 610

(Note: Multiply lbs. by 2.2 for Kg and Multiply in. by 2.54 for cm)

Anodes shall be provided in packaged form with the anode surrounded by specially-prepared quick-wetting backfill and contained in a water permeable cloth or paper sack. Anodes shall be centered by means of spacers in the backfill material. The backfill material shall be composed of 75 percent Gypsum, 20 percent Bentonite, and 5 percent Sodium Sulphate by weight unless otherwise approved by the Engineer.

2.2.02 Zinc Anodes. Zinc anodes shall conform to ASTM B 418 , Type II.

2.2.03 Connecting Wire. Any pinhole, cut, scratch or other damage to the anode cable exposing bare copper to the electrolyte will result in early failure of the cathodic protection system. For this reason, special, extra heavy insulation shall be used on anode cable.

Wire shall be AWG solid copper wire, not less than 10 feet (3 m) long, un-spliced, complying with NFPA 70 insulation. Type RHH insulation shall be used under hot asphalt. Connecting wires for magnesium anodes shall be factory installed with the place or emergence from the anode in a cavity sealed flush with a dielectric sealing compound. Connecting wires for zinc anodes shall be factory installed with the place of connection to the protruding steel core completely sealed with a dielectric material.

Cables for anode header and distribution shall be AWG stranded copper wire with type CP high molecular weight polyethylene, 7/64 inch (2.8 mm) thick insulation, 600-volt rating, in accordance with NEMA WC 5.

2.2.04 Electrical Wire. Wire shall be AWG stranded copper wire with NFPA 70 , insulation. Polyethylene insulation, if used, shall comply with the requirements of ASTM D 1248 and shall be of the following types, classes, and grades: High-molecular weight polyethylene shall be Type I, Class C, Grade E5 and High-density polyethylene shall be Type III, Class C, Grade E3.

Test wires shall be AWG No. 12 stranded copper wire with NFPA 70, Type TW or RHW or polyethylene insulation.

Resistance wire shall be AWG No. 16 or No. 22 nickel-chromium wire with TW insulation.

2.2.05 Wire Splicing. Connecting wire splicing shall be made with copper compression connectors or exothermic welds, following instructions of the manufacturer. Single split-bolt connections shall not be used. Sheaths for encapsulating electrical wire splices to be buried underground shall fit the insulated wires entering the spliced joints and epoxy potting compound shall be as specified below.

In buried metallic tanks, split bolts may be used. A minimum of two split bolts shall be used. At ground level or in trenches, the swaged sleeve connection shall be used.

2.2.06 Conduit. Rigid galvanized steel conduit and accessories shall conform to UL 6. Non metallic conduit shall conform to NEMA TC 2.

2.2.07 Test Boxes and Junctions Boxes. Boxes shall be outdoor type conforming to UL 514A.

2.2.08 Joint, Patch, Seal, and Repair Coating. Sealing and dielectric compound shall be a black, rubber based compound that is soft, permanently pliable, tacky, moldable, and unbacked. Compound shall be applied as recommended by the manufacturer, but not less than 1/2 inch (13 mm) thick. Coating compound shall be cold-applied coal-tar base mastic. Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.09 Backfill Shields. Shields shall consist of approved pipeline wrapping or fiberglass-reinforced, coal-tar impregnated tape, or plastic weld caps, specifically made for the purpose and installed in accordance with the manufacturer's recommendations. When joint bonds are required, due to the use of mechanical joints, the entire joint shall be protected by the use of a kraft paper joint cover. The joint cover shall be filled with poured-in, hot coat-tar enamel.

2.2.10 Epoxy Potting Compound. Compound for encapsulating electrical wire splices to be buried underground shall be a two package system made for the purpose.

2.2.11 Test Stations. Stations shall be of the flush-curb-box type and shall be the standard product of a recognized manufacturer. Test stations shall be complete with an insulated terminal block having the required number of terminals. Each test station shall be provided with a lockable over and shall have an embossed legend, "C.P. Test." A minimum of 1 test station shall be provided for each component of the pipe. A minimum of 6 terminals shall be provided in each test station. A minimum of 2 leads is required to the metallic pipe from each test station. Other conductors shall be provided for each anode, other foreign pipe, and reference cells as required. Test stations may be constructed of nonmetallic materials. However, if nonmetallic materials are utilized, as a minimum, the materials shall be resistant to damage from ultraviolet radiation, contain good color retention qualities, contain high strength qualities, and be resistant to accidental or vandalistic impacts. The test stations shall be listed for the particular application for which they are to be utilized.

2.2.12 Electrical Connections. Electrical connections shall be made using Exothermic welds such as "Cadweld", " Bundy", "Thermoweld" or approved equal. Use of this material shall be in strict accordance with the manufacturer's recommendations.

Electrical-shielded arc welds shall be approved for use on steel pipe by shop drawing submittal action.

2.2.13 Electrical Tape. Pressure-sensitive vinyl plastic electrical tape shall conform to UL 510.

2.2.14 Permanent Reference Electrodes. Permanent reference electrodes shall be Cu-CuS04 electrodes suitable for direct burial. The supplier shall guarantee electrodes for 25 years of service in the environment in which they shall be placed. Electrodes shall be installed directly beneath pipe, or metallic component.

2.2.15 Casing. Where a pipeline is installed in a casing under a structure, roadway or railway, the pipeline shall be electrically insulated from the casing, and the annular space sealed and filled with an approved corrosion inhibiting product against incursion of water.

2.3 ELECTRICAL ISOLATION OF STRUCTURES. Isolation fittings, including isolating flanges and couplings, shall be installed aboveground or in a concrete pit. As a minimum, isolating flanges or unions shall be provided at the following locations:

Connection of new metallic piping or components to existing piping.

Pressure piping under floor slab of a building.

Metallic connection of all lines to existing system and where connecting to a building.

Between water and/or force main and foreign pipes that cross within 10 feet (3.1 m) of the new line.

If the new piping is a short extension to an existing old piping system not under cathodic protection, an isolating fitting shall be installed at the point of connection. If the older system is under cathodic protection, no isolating fitting need be used.

2.3.01 Electrically Isolating Pipe Joints. Electrically isolated pipe joints shall be of a type that is in regular factory production.

2.3.02 Electrically Conductive Couplings. Electrically conductive couplings shall be of a type that has a published maximum electrical resistance rating given in the manufacturer's literature. Cradles and seals shall be of a type that is in regular factory production made for the purpose of electrically insulating the carrier pipe from the casing and preventing the incursion of water into the annular space.

2.3.03 Insulating Joint Testing. A Model 601 Insulation Checker, as manufactured by "Gas Electronics", or approved equal, shall be used for insulating joint (flange) electrical testing.

2.4 UNDERGROUND STRUCTURE COATING. This coating specification shall take precedence over any other project specification and drawing notes, whether stated or implied, and shall also apply to the pipeline or tank supplier. No variance in coating quality shall be allowed by the Contractor or Base Construction Representative without the written consent of the designer. All underground metallic pipelines and tanks to be cathodically protected shall be afforded a good quality factory-applied coating. This includes all carbon steel, cast-iron and ductile-iron pipelines or vessels. Coatings shall be selected, applied, and inspected in accordance with NACE RP0190 and as specified. If non-metallic pipelines are installed, all metallic fittings on pipe sections shall be coated in accordance with this specification section.

The nominal dry thickness of the metallic pipe joint or other component coating shall be 8 mils (0.2 mm), plus or minus 5 percent.

Pipe and joint coating for factory applied or field repair material shall be applied as recommended by the manufacturer and shall be one of the following:

Continuously extruded polyethylene and adhesive coating system.

Polyvinyl chloride pressure-sensitive adhesive tape.

High density polyethylene/bituminous rubber compound tape.

Butyl rubber tape.

Coal tar epoxy.

2.4.01 Field Joints. All field joints shall be coated with materials compatible with the pipeline coating compound. The joint coating material shall be applied to an equal thickness as the pipeline coating. Unbonded coatings shall not be used on these buried metallic components. This includes the elimination of all unbonded polymer wraps or tubes. Once the pipeline or vessel is set in the trench, an inspection of the coating shall be conducted. This inspection shall include electrical holiday detection. Any damaged areas of the coating shall be properly repaired. The Engineer shall be asked to witness inspection of the coating and testing using a holiday detector.

2.4.02 Protective covering for aboveground piping systems. Finish painting shall conform to the applicable paragraph in Master Specification Section 09900, Painting, and as follows: shop-primed ferrous surfaces shall be touched-up with ferrous metal primer. Surfaces that have not been shop-primed shall be solvent-cleaned. Surfaces that contain loose rust, loose mil scale, and other foreign substances shall be mechanically-cleaned by power wire-brushing and primed with ferrous metal primer. Primed surface shall be finished with 2 coats of exterior paint. Coating for each entire piping service shall be an approved pipe line wrapping having a minimum coating resistance of 50,000 Ohms per square foot (0.0929 Ohms sq m).

PART 3 - EXECUTION

3.1 INSPECTION.

3.1.01 Inspection of Pipe Coatings. Any damage to the protective covering during transit and handling shall be repaired before installation. After field coating and wrapping has been applied, an electric holiday detector shall inspect the entire pipe with impressed current in accordance with NACE RP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal that sounds when a holiday is detected. All holidays in the protective covering shall be repaired immediately upon detection. Occasional checks of holiday detector potential will be made by the Engineer's representative to determine suitability of the detector. The Contractor shall furnish all labor, materials, and equipment necessary for conducting the inspection.

3.2 INSTALLATION.

3.2.01 Excavation. In the event rock or other underground obstruction is encountered in providing the required depth for anodes, the Contractor shall determine an alternate approved location and, if the depth is still not provided, an alternate plan shall be submitted to the Engineer. Alternate techniques and depths shall be approved prior to implementation.

Trenching and backfilling shall be in accordance with Master Specification Section 02221, Trenching, Backfilling, and Compacting.

3.2.02 Anode Installation. Unless otherwise authorized, installation shall not proceed without the presence of the Engineer. Anodes of the size specified shall be installed to the depth indicated and at the locations shown. Locations may be changed to clear obstructions with the approval of the Engineer. Anodes shall be installed in sufficient number and of the required type, size, and spacing to obtain a uniform current distribution over the surface of the structure. The anode system shall be designed for a life of 25 years of continuous operation. Anodes shall be installed as indicated in a dry condition after any plastic or waterproof protective covering has been completely removed from the water permeable, permanent container housing the anode metal. The anode connecting wire shall not be used for lowering the anode into the hole. The annular space around the anode shall be backfilled with fine sand or gravel in 6 inch (150 mm) layers and each layer shall be hand tamped. Care shall be exercised not to strike the anode or connecting wire with the tamper. Approximately 5 gallons (20 L) of water shall be applied to each filled hole after anode backfilling and tamping has been completed to a point about 6 inches (150 mm) above the anode. After the earth has absorbed the water, backfilling shall be completed to the ground surface level.

Single anodes, spaced as shown, shall be connected through a test station to the pipeline, allowing adequate slack in the connecting wire to compensate for movement during backfill operation.

Groups of anodes, in quantity and location shown, shall be connected to an anode header cable. The anode header cable shall make contact with the structure to be protected only through a test station. Anode lead connection to the anode header cable shall be made by an approved crimp connector or exothermic weld and splice mold kit with appropriate potting compound.

Connections to ferrous pipe shall be made by exothermic weld methods manufactured for the type of pipe supplied. Electric arc welded connections and other types of welded connections to ferrous pipe and structures shall be approved before use.

3.2.03 Underground Pipeline. Anodes shall be installed at a minimum of 8 feet (2.5 m) and a maximum of 10 feet (3 m) from the line to be protected.

3.2.04 Lead Wire Connections. For underground metallic pipelines, all anode lead wires shall be connected to a test station and buried a minimum of 24 inches (610 mm) in depth to facilitate periodic electrical measurements during the life of the sacrificial anode system and to reduce the output current of the anodes. The cable shall be No. 10 AWG, stranded copper, polyethylene or RHW-USE insulated cable. The cable shall make contact with the structure only through a test station. Resistance wire shall be installed between the cable and the pipe cable, in the test station, to reduce the current output, if required. Anode connections, except in the test station, shall be made with exothermic welding process, and shall be insulated by means of at least 3 layers of electrical tape; and all lead wire connections shall be installed in a moistureproof splice mold kit and filled with epoxy resin. An exothermic welding process shall accomplish lead wire-to-structure connections. All welds shall be in accordance with the manufacturer's recommendations. A backfill shield filled with a pipeline mastic sealant or material compatible with the coating shall be placed over the weld connection and shall be of such diameter as to cover the exposed metal adequately.

Resistance wire connections shall be accomplished with silver solder and the solder joints wrapped with a minimum of 3 layers of pressure-sensitive tape. Lead wire connections shall be installed in a moistureproof splice mold kit and filled with epoxy resin.

3.2.05 Location of Test Stations. Test stations shall be of the type and location shown and shall be curb box mounted. Buried insulating joints shall be provided with test wire connections brought to a test station. Unless otherwise shown, other test stations shall be located as follows:

At 1,000 foot (300 m) intervals or less.

Where the pipe or conduit crosses any other metal pipe.

At both ends of casings under roadways and railways.

Where both sides of an insulating joint are not accessible above ground for testing purposes.

3.2.06 Joint and Continuity Bonds. Bonds shall be provided across all joints in the metallic buried lines, across any electrically discontinuous connections and all other pipes and structures with other than welded or threaded joints that are included in this cathodic protection system. Unless otherwise specified in the specifications, bonds between structures and across joints in pipe with other than welded or threaded joints shall be No. 8 AWG stranded copper cable with polyethylene insulation. Bonds between structures shall contain sufficient slack for any anticipated movement between structures. Bonds across pipe joints shall contain a minimum of 4 inches (102 mm) of slack to allow for pipe movement and soil stress. Bonds shall be attached by exothermic welding. Exothermic weld areas shall be insulated with coating compound and approved, and witnessed by the Engineer. Continuity bonds shall be installed as necessary to reduce stray current interference. Additional joint bonding shall be accomplished by the Contractor where the necessity is discovered during construction or testing or where the Engineer's representative directs such bonding to be done. Joint bonding shall include all associated excavation and backfilling. There shall be a minimum of 2 continuity bonds between each structure and other than welded or threaded joints. The Contractor shall test for electrical continuity across all joints with other than welded or threaded joints and across all metallic portions or components. The Contractor shall provide bonding as required and as specified above until electrical continuity is achieved. Bonding test data shall be submitted for approval.

3.2.07 Resistance Bonds. Resistance bonds should be adjusted as outlined in this specification. Alternate methods may be used if the Engineer approves them.

3.2.08 Isolation Joints and Fittings. Isolating fittings, including main line isolating flanges and couplings, shall be installed aboveground, or within manholes, wherever possible. Where isolating joints must be covered with soil, they shall be fitted with a paper joint cover specifically manufactured for covering the particular joint, and the space within the cover filled with hot coal-tar enamel. Isolating fittings in lines entering buildings shall be located at least 12 inches (305 mm) above grade or floor level, when possible. Isolating joints shall be provided with grounding cells to protect against over-voltage surges or approved surge protection devices. The cells shall provide a low resistance across isolating joint without excessive loss of cathodic current.

3.2.09 Gas Distribution Piping. Electrical isolation shall be provided at each building riser pipe to the pressure regulator, at all points where a short to another structure or to a foreign structure may occur, and at other locations as indicated on the drawings.

3.2.10 Coatings. All aboveground pipeline shall be coated as indicated or as approved. The coating shall have a minimum thickness of 7 mil (0.18 mm). The pipeline coating shall be in accordance with all applicable Federal, State, and local regulations.

3.2.11 Clearing of Trees and Underbrush. In the areas of the anode beds, all trees and underbrush shall be cleared and grubbed to the limits shown or indicated.

3.2.12 Seeding. The Contractor, as directed, in all un-surfaced locations disturbed by this construction shall do seeding as specified in Division 2. In areas where grass cover exists, it is possible that sod can be carefully removed, watered, and stored during construction operations, and replaced after the operations are completed since it is estimated that no section of pipeline should remain uncovered for more than 2 days. The use of sod in lieu of seeding shall require approval by the Engineer.

3.2.13 Cleanup. The Contractor shall be responsible for cleanup of the construction site. All paper bags, wire clippings, etc., shall be disposed of as directed.

3.3 FIELD QUALITY CONTROL. Acceptance criteria for determining the adequacy of protection on a buried underground pipe shall be in accordance with NACE RP0169 and as specified below.

3.3.01 Iron and Steel. The following method shall be used for testing cathodic protection voltages.

A negative voltage of at least minus 850 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode connecting the earth (electrolyte) directly over the underground component. Determination of this voltage shall be made with the cathodic protection system in operation. Voltage drops shall be considered for valid interpretation of this voltage measurement. A minimum of minus 850 millivolts "instant off" potential between the underground component being tested and the reference cell shall be achieved over 95 percent of the area of the structure. Adequate number of measurements shall be obtained over the entire structure, pipe, tank, or other metallic component to verify and record achievement of minus 850 millivolts "instant off." This potential shall be obtained over 95 percent of the total metallic area without the "instant off" potential exceeding 1150 millivolts.

If more than one method is required, this method shall also be used. A minimum polarization voltage shift of 100 millivolts as measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth directly over the underground component. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay. Measurements achieving 100 millivolts decay shall be made over 95 percent of the metallic surface being protected.

For any metallic component, a minimum of 4 measurements shall be made using the methods outlined in the above subparagraph, and achieving the "instant off" potential of minus 850 millivolts. Two measurements shall be made over the anodes and 2 measurements shall be made at different locations near the component and farthest away from the anode.

3.3.02 Aluminum. Aluminum underground component shall not be protected to a potential more negative than minus 1200 millivolts, measured between the underground component and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the metallic component. Resistance, if required, shall be inserted in the anode circuit within the test station to reduce the potential of the aluminum to a value which will not exceed a potential more negative than minus 1200 millivolts. Voltage shift criterion shall be a minimum negative polarization shift of 100 millivolts measured between the metallic component and a saturated copper-copper sulphate reference electrode contacting the earth, directly over the metallic component. The polarization voltage shift shall be determined as outlined for iron and steel.

3.3.03 Copper Piping. Copper piping shall have a minimum of 100 millivolts of cathodic polarization between the structure surface and a stable reference electrode contacting the electrolyte. The polarization voltage shift shall be determined as outlined for iron and steel.

3.4 TESTS AND MEASUREMENTS.

3.4.01 Baseline Potentials. Each test and measurement will be witnessed by the Engineer. The Contractor shall notify the Engineer a minimum of 5 working days prior to each test. After backfill of the pipe, the static potential-to-soil of the pipe shall be measured. The locations of these measurements shall be identical to the locations specified for pipe-to-reference electrode potential measurements. The initial measurements shall be recorded.

3.4.02 Isolation Testing. Before the anode system is connected to the pipe, an isolation test shall be made at each isolating joint or fitting. This test shall demonstrate that no metallic contact, or short circuit exists between the two isolated sections of the pipe. Any isolating fittings installed and found to be defective shall be reported to the Engineer.

A Model 601 insulation checker, as manufactured by "Gas Electronics", or an approved equal, using the continuity check circuit, shall be used for isolating joint (flange) electrical testing. Testing shall conform to the manufacturer's operating instructions. Test shall be witnessed by the Engineer. An isolating joint that is good will read full scale on the meter. If an isolating joint is shorted, the meter pointer will be deflected or near zero on the meter scale. Location of the fault shall be determined from the instructions, and the joint shall be repaired. If an isolating joint is located inside a vault, the pipe shall be sleeved with insulator when entering and leaving the vault.

Meter A Model B3A2 cathodic protection meter, as manufactured by "M.C. Miller", or an approved equal, using the continuity check circuit, shall be used for isolating joint (flange) electrical testing. This test shall be performed in addition to the Model 601 insulation checker. Continuity is checked across the isolation joint after the test lead wire is shorted together and the meter adjusted to scale. A full-scale deflection indicates the system is shorted at some location. The Model 601 verifies that the particular insulation under test is good and the Model B3A2 verifies that the system is isolated. If the system is shorted, further testing shall be performed to isolate the location of the short.

3.4.03 Anode Output. As the anodes or groups of anodes are connected to the pipe, current output shall be measured with an approved clamp-on milliammeter. The values obtained and the date, time, and location shall be recorded.

3.4.04 Reference Electrode Potential Measurements. Upon completion of the installation and with the entire cathodic protection system in operation, electrode potential measurements shall be made using a copper-copper sulphate reference electrode and a potentiometer-voltmeter, or a direct-current voltmeter having an internal resistance (sensitivity) of not less than 10 megohms per volt and a full scale of 10 volts. The locations of these measurements shall be identical to the locations used for baseline potentials. The values obtained and the date, time, and locations of measurements shall be recorded. No less than 8 measurements shall be made over any length of line or component. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line.

3.4.05 Location of Measurements. For coated piping or conduit, measurements shall be taken from the reference electrode located in contact with the earth, directly over the pipe. Connection to the pipe shall be made at service risers, valves, test leads, or by other means suitable for test purposes. Pipe-to-soil potential measurements shall be made at intervals not exceeding 10 feet 3 (m). The Contractor may use a continuous pipe-to-soil potential profile in lieu of 10 foot (3 m) interval pipe-to-soil potential measurements. Additional measurements shall be made at each distribution service riser, with the reference electrode placed directly over the service line adjacent to the riser. Potentials shall be plotted versus distance to an approved scale. Locations where potentials do not meet or exceed the criteria shall be identified and reported to the Engineer's representative.

3.4.06 Casing Tests. Before final acceptance of the installation, the electrical separation of carrier pipe from casings shall be tested and any short circuits corrected.

3.4.07 Interference Testing. Before final acceptance of the installation, interference tests shall be made with respect to any foreign pipes in cooperation with the owner of the foreign pipes. A full report of the tests giving all details shall be made. Stray current measurements shall be performed at all isolating locations and at locations where the new pipeline crosses foreign metallic pipes. The method of measurements and locations of measurements shall be submitted for approval. As a minimum, stray current measurements shall be performed at the following locations:

Connection points of new pipeline to existing pipeline.

Crossing points of new pipeline with existing lines. Results of stray current measurements shall also be submitted for approval.

3.4.08 Holiday Tests. Any damage to the protective covering during transit and handling shall be repaired before installation. After field-coating and wrapping has been applied, the entire pipe shall be inspected by an electric holiday detector with impressed current in accordance with NACE RP0188 using a full-ring, spring-type coil electrode. The holiday detector shall be equipped with a bell, buzzer, or other type of audible signal which sounds when a holiday is detected. Holidays in the protective covering shall be repaired upon detection. Occasional checks of holiday detector potential will be made by the Engineer to determine suitability of the detector. Labor, materials, and equipment necessary for conducting the inspection shall be furnished by the Contractor. The coating system shall be inspected for holes, voids, cracks, and other damage during installation.

All pipe to-soil potential measurements, including initial potentials where required, shall be recorded. The Contractor shall locate, correct and report to the Engineer any short circuits to foreign pipes encountered during checkout of the installed cathodic protection system. Pipe to-soil potential measurements shall be taken on as many pipes as necessary to determine the extent of protection or to locate short-circuits.

3.4.09 Stray Current Measurements. Stray current measurements shall be performed at each test station. Stray currents resulting from lightning or overhead alternating current (AC) power transmission systems shall be mitigated in accordance with NACE RP0177.

3.4.10 Test Report. The Contractor shall submit a report including potential measurements taken at adequately-close intervals to establish that minus 850 millivolts potential, "instant-off" potential, is provided, and that the cathodic protection is not providing interference to other foreign pipes causing damage to paint or pipes. The report shall provide a narrative describing how the criteria of protection is achieved without damaging other pipe or structures in the area.

3.5 MAINTENANCE.

3.5.01 Operations and Maintenance Data. Before final acceptance of the cathodic protection system, submit operating manuals outlining the step-by-step procedures required for system startup, operation, adjustment of current flow, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Provide maintenance manual, listing routine maintenance procedures, recommendation for maintenance testing, possible breakdowns and repairs, and troubleshooting guides. The manuals shall include single-line diagrams for the system as installed; instructions in making pipe-to-reference cell and tank-to-reference cell potential measurements and frequency of monitoring; instructions for dielectric connections, interference and sacrificial anode bonds; instructions shall include precautions to ensure safe conditions during repair of pipe or other metallic systems. The instructions shall be neatly bound between permanent covers and titled "Operating and Maintenance Instructions." These instructions shall be submitted for the Engineer's approval. The instructions shall include the following:

> As-built drawings, to scale of the entire system, showing the locations of the piping, location of all anodes and test stations, locations of all insulating joints, and structure-to-reference cell potentials as measured during the tests required in paragraph above on Tests and Measurements.

Recommendations for maintenance testing, including instructions in making pipe-to-reference cell potential measurements and frequency of testing.

All maintenance and operating instructions and nameplate data shall be in English.

Instructions shall include precautions to insure safe conditions during repair of pipe system.

3.5.02 Training Course. The Contractor shall conduct a training course for the operating staff as designated by the Engineer. The training period shall consist of a total of 8 hours of normal working time and shall start after the system is functionally completed but prior to final acceptance tests. The field instructions shall cover all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions. At least 14 days prior to date of proposed conduction of the training course, the training course curriculum shall be submitted for approval, along with the proposed training date. Training shall consist of demonstration of test equipment, providing forms for test data and the tolerances that indicate that the system works.

The Contractor shall furnish a reference cell on a reel with 350 feet (120 m) of conductor, along with other accessories, and a digital voltmeter that can be used in the maintenance of this cathodic protection system. Use of this equipment shall be demonstrated in actual tests during the training course, which shall include a description of the equipment and measurement of the pipe-to-soil potential.

The proposed Training Course Curriculum (including topics and dates of discussion) indicating that all of the items contained in the operating and maintenance instructions, as well as demonstrations of routine maintenance operations, including testing procedures included in the maintenance instructions, are to be covered.

End of Section

SECTION 13200

PRE-ENGINEERED METAL UNITS

PART 1 – GENERAL

1.1 SCOPE. This section addresses the construction and installation of pre-fabricated, pre-engineered, metal buildings, vaults and structure units. Pre-engineered units shall be fabricated at the plant and erected onsite. Pre-fabricated units, shall be pre-assembled at the factory and set into place and anchored to foundations or slabs.

1.2 GENERAL.

1.2.01 Governing Standards.

AISC (American Institute of Steel Construction) – Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

ASTM (American Society of Testing Materials) A36/A36M - Specification for Carbon Structural Steel.

ASTM A123/A123M – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A283/A283M - Specification for low and Intermediate Tensile Strength Carbon Steel Plates.

ASTM A307 – Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

ASTM A325 – Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

ASTM A490 – Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.

ASTM A500 – Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A501 – Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

ASTM A529/A529M – Specification for High-Strength Carbon-Manganese Steel of Structural Quality.

ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

AWS (American Welding Society) D1.1 – Structural Welding Code.

FS (Federal Specification) HH-I-521 – Insulation Blankets, Thermal, Mineral fiber.

FS TT-P-31 – Paint, Oil: Iron-Oxide, Ready Mixed, Red and Brown.

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Provide certification that welders to be employed in the Work are certified by AWS and applicable local building officials, and have been re-certified in the last 12 months.

1.3.02 Installer's Qualifications. Installer shall have a record of at least 5 years of successful installation of units similar to those required for this Project.

1.3.03 Fabricator's Qualifications. Firm shall have a minimum of 5 years experience in producing units similar to those required for this Project, with sufficient production capacity to produce and deliver required units without causing delay in the Work. Fabricating plant shall be certified by one of the following:

Architectural Precast Association (APA)

Precast/Prestressed Concrete Institute (PCI), Group A1

Applicable municipal building department

Firms not certified by APA or PCI shall submit a written Quality Assurance/Quality Control program for approval

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit all shop drawings and product data, indicating the profiles, sizes, spacing, and locations of structural members. Also identify attachments, openings, fasteners, cambers, loads, welded connections using standard AWS welding symbols, net weld lengths, framing anchor bolt settings, sizes, anode alarm system and other components, and locations from datum.

The manufacturer shall sign and submit design analysis, fabrication and installation calculations for all pre-engineered units. The analysis shall be prepared by an Engineer registered in the State of Michigan and shall include loadings, stresses, size selections, shape selections, bearing and anchorage point loadings.

Indicate wall and roof system dimensions, panel layout, general construction details, anchorages, method of anchorage from uplifting forces, and method of installation. Submit manufacturer's installation instructions.

The Metal Vault Unit (MVU) shall be designed, signed and sealed by a Professional Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING. Units shall be adequately protected during all transportation, loading and unloading, storage, installation, and subsequent construction activities. Repairs of minor damage, including scratches and abrasions, may be made where permitted by the Engineer in the manner recommended by the manufacturer. If a unit is damaged beyond reasonable repair, in the opinion of the Engineer, it will be rejected and shall be replaced by the Supplier with an undamaged unit.

All lifting of factory assembled units shall be done using properly designed crane eyes installed at roof on all four sides.

1.6 WARRANTY. The manufacturer of the pre-engineered units shall provide a ten-year warranty for exterior pre-finished surfaces. Manufacturer's warranty shall cover pre-finished color coat against chipping, cracking or crazing, blistering, peeling, chalking, or fading. All other warranties shall be in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 BUILDING PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Metal buildings shall have clear span rigid frame or modular rigid frame supported with intermediate columns or truss system as required and approved by Engineer.

Primary Framing shall consist of rigid frame or rafter beams and columns, canopy beams, intermediate columns, braced end frames, end wall columns, and wind bracing. Secondary Framing shall consist of purling, girts, eave struts, flange bracing, sill supports, clips, and other items as required. Wall and Roof System shall consist of pre-formed metal panels of vertical profile, with appropriate framing/anchorage assembly, insulation, liner sheets, and accessory components as required.

Members shall withstand dead load, applicable snow load, and design loads due to piping, equipment, pressure and suction of wind calculated in accordance with applicable local and state codes. Exterior wall and roof systems shall withstand imposed loads with maximum allowable span deflection of 1/90. The Vault shall withstand uplifting forces.

Provide drainage to exterior for water entering or condensation occurring within cladding system. Thermal Resistance of Wall System shall be 'R' value of not less than 11. Thermal Resistance of Roof System shall be 'R' value of not less than 19.

Assembly shall permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects, when subject to temperature range of –20 degrees F to 120 degrees F (-28.8 degrees C to 48.9 degrees C).

Size and fabricate wall and roof systems to be free of distortion or defects detrimental to appearance or performance.

All openings required for equipment or shown on the Drawings shall be properly framed with structural members.

Foundations: Provide reactions from all columns and walls to the foundations. Provide anchor bolt layout and templates as required to allow the installer to provide a suitable foundation for the proposed building.

Applicable design and layout of foundations, equipment bases, toilets and utilities shall be provided on drawings by design Engineer or Owner. Contractor shall meet these requirements by selecting units that can handle design elements identified by Engineer or Owner.

2.2 BUILDING MATERIALS.

2.2.01 Building Framing Materials. Structural Steel Members shall meet ASTM A36. Structural Tubing shall meet ASTM A500, Grade B. Plate or Bar Stock shall meet ASTM A529.

Anchor Bolts shall meet ASTM A325. Bolts, Nuts, and Washers shall meet ASTM A325, A490, A307. Welding Materials shall meet AWS D1.1 for the materials being welded. Primer shall be FS TT-P-31, red.

Non-shrink Grout shall be premixed compound consisting of non-metallic aggregate, cement, water, reducing and plasticizing agents, developing minimum compressive strength of 2400 psi (16,548 kPa) in two days and 7000 psi (48,264 kPa) in 28 days.

2.2.02 Building Wall and Roof System. Sheet Steel Stock shall be ASTM A653, Grade A; zinc-coated (galvanized).

Insulation shall be FS HH-I-521 Semi-rigid glass fiber type, faced with white vinyl; UL flame-spread classification of 25 or less where exposed; and friction fit.

Fasteners shall be Manufacturer's standard galvanized types. Finish to match adjacent surfaces when exterior exposed.

Joint Seal Gaskets shall be Manufacturer's standard. Sealant shall be manufacturer's standard. Bituminous Paint shall be asphaltic type.

2.2.03 Building Doors, Frames, and Windows. Shall be provided in accordance with Master Specification Division 8, Doors and Windows or as approved by Engineer.

2.3 BUILDING MANUFACTURE AND FABRICATION.

2.3.01 Building Framing. Fabricate frame members in accordance with AISC Specification for plate, bar, tube, or rolled structural shapes. Roof Slope shall be 2 inch in 12 inches (1 cm in 6 cm) or manufacturers standard.

Anchor Bolts shall be formed with bent straight shank, unprimed, zinc coated and assembled with template for casting into concrete.

Building overhead Door Frame shall be formed steel sections braced to building frame.

2.3.02 Building Gutter and Downspouts. Fabricate of same material and finish as roofing metal. Form gutters and downspouts and scuppers to match building and size to collect and remove water.

Form sections in maximum possible lengths. Hem exposed edges. Allow for expansion at joints. Fabricate support straps of same material and finish as roofing metal, color as selected.

2.3.03 Building Framing Finish. Clean, prepare, and shop prime framing members. Galvanize framing members. Do not prime surfaces to be field welded.

2.3.04 Acceptable Manufacturers. Acceptable fabricators include Nucor Building Systems, Butler Manufacturing, American Buildings, or approved equal.

PART 3 - EXECUTION

3.1 BUILDING INSTALLATION.

3.1.01 Framing Erection. Erect framing in accordance with AISC Specification. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing. Set column base plates with non-shrink grout to full plate bearing. Do not field cut or alter structural members without approval of Engineer.

After erection, prime welds, abrasions, and surfaces not shop primed. Use a primer consistent with shop coat. Use primer recommended for galvanized surfaces.

3.1.02 Wall and Roofing Systems. Install in accordance with manufacturer's instructions and Master Specification Division 7, Thermal & Moisture Protection. Exercise care when cutting pre-finished material to ensure cuttings do not remain on finished surface. Fasten cladding system to structural supports, aligned level and plumb.

Locate end laps over supports. Overlap panel ends a minimum of 2 inches (5.1 cm). Place sidelaps over bearing. Provide expansion joints. Use concealed fasteners. Install sealant and gaskets to prevent weather penetration. System shall be free of rattles, noise due to thermal movement, and wind whistles.

3.1.03 Installation of Accessories. Install doorframe, door, overhead door, window and glass, in accordance with manufacturer's instructions and Master Specification Division 8, Doors and Windows. Seal wall and roof accessories watertight and weather-tight with sealant. Provide all applicable grounding and wiring in accordance with Master Specification Section 16050, Electrical.

3.1.04 Gutter and Downspout Erection. Rigidly support and secure components. Joint lengths with formed seams sealed watertight. Flash and seal gutters to downspouts. Apply bituminous paint on surfaces in contact with cementious materials. Slope gutters minimum 1/16 inch per foot (5.2 mm per m). Install plash pads.

3.2 METAL VAULT UNITS. Furnish and install factory-built metal meter vault units at each location shown on the Drawings. The meter vault shall be assembled at the factory and consist of a prefabricated steel vault with entrance tube, ventilation fan system, ladder, electrical controls, sump pump and piping, cathodic protection with anode alarm system, wiring and lighting. Valves, meters, fittings and other equipment shall be placed in units as directed by Engineer. Appropriate clearances around all equipment shall be maintained. Pipes installed through units shall be performed as directed by manufacturer. Provide all applicable grounding and wiring in accordance with Master Specification Section 16050, Electrical. Gate boxes shall be installed per the manufacturer's instructions and in accordance with Master Specification Section 02620, Water Main Services.

The manufacturer shall assume full responsibility for the structural adequacy of the vault structure. The manufacturer shall determine the size, placements, and connections of all structural members. The manufacturer shall determine the plate thickness and reinforcement required. The steel vault, including roof and access hatch, shall be designed for a superimposed load of 300 psf (14.4 kPa), in addition to piping, backfill and other dead loads. The backfill shall be assumed to weigh 120lbs. per cu ft (1,922.2 kg per cu m). The walls shall be designed assuming and external pressure equivalent to a fluid weighing 60 pcf (961.1 kg per cu m). The entire vault shall also be designed for the specified internal test pressure assuming no backfill is in place. Openings shall be tightly sealed with Linkseal, by Thunderline Corporation, or equal to assure compliance with the quality control air tests as stated herein.

All mechanical thrusts, restraints, tie rods and supports shall be correctly designed, sized, and installed to prevent movement of Dresser Type Coupling, Gate Valves, pipes, equipment and other Vault components.

After installation of all components and completion of all penetrations, the steel vault shall be subject to an air test to assure the watertight integrity of the weld system. A test pressure of 3 psi (20.7 kPa) shall be maintained while a soap solution is applied to all welded joints on the exterior of the steel vault. The test pressure shall be measured by means of a tested and properly calibrated pressure gage. Openings in the vault shall be sealed against leakage.

All welds found to be defective shall be repaired and the vault shall be retested. Six certified copies of a report covering each test shall be prepared by the Contractor and delivered to the Engineer not less than 10 days prior to shipment of the vault.

The manufacturer shall provide at least four 3/8 inch (9.5 mm) thick lifting plates about the perimeter of the vault to ensure proper balance of the vault during the setting operation.

The steel vault shall be complete with a sump to accommodate the automatic sump pump specified elsewhere. The sump shall be a minimum of 18 inches (45.7 cm) in diameter and 8 inches (20.3 cm) deep; and shall be fabricated of plate 1/4 inch (6.4 mm) minimum thickness. The sump shall be located so as to ensure proper and complete drainage of the steel vault floor. The steel vault shall be capable of installing two sumps pumps.

The prefabricated master meter vaults shall be as manufactured by Engineered Fluid Inc. (EFI) or equal.

3.2.01 Access Hatch. The access hatch shall consist of a Bilco Type J or S steel access hatch, or equal as specified in Master Specification Section 05630, Access Hatches. Neither factory nor field welding of the access hatch to the entrance tube will be permitted. Size shall be as shown on the Drawings. All access hatches for vaults shall be designed to support an H-20 wheel load.

A flashing system clip shall be provided on the outside of the vault that shall lip the top of the riser with insulation. The flashing clip shall be fastened watertight to the riser flange so the insulation remains dry under all conditions.

The access hatch attachment system shall include but not be limited to 10 - 1/4 inch (6.4 mm) diameter stainless steel flange bolts with nuts and 2 flat washers each, bedding compound sealant, 4504 Scotch polyfoam and single side adhesive coated 1/4 inch (6.5 mm) by 3 inch (7.6 cm) gasket materials.

3.2.02 Prefabricated Steel. The plate forming the top and bottom of the capsule shall be cold formed prior to assembly so as to form a lap joint with the sidewall. The lap joint shall be continuously welded on the interior by hand and continuously welded on the exterior by machine to form an airtight seal. The lower side wall continuous weld shall be an average 1 1/2 inches (3.8 cm) above the capsule floor, which removes the lower weld from incidental water impingement. Sidewall to shell butt welds made at floor level will not be accepted. The lap joint shall be in full conformance with Steel Tank Institute (STI) P-3 specifications Section 4.2.6 and Underwriters Laboratories (UL) 58 specifications for steel vessels in buried service, and the American Welding Society (AWS) Structural Welding Code, Section 9.10,

The steel plate used in constructing the vault shall be at least 1/4 inch (6.4 mm) thick and meet or exceed the requirements of ASTM A283, Grade D. Steel for structural members shall meet or exceed the requirements of ASTM A36.

> The bottom of the vault shall be reinforced by structural steel channels and rectangular structural tube in parallel. There shall also be channels in parallel, placed perpendicularly to the channels and tubes.
>
> The top of the vault shall be a reinforced structure. The capsule shall be designed and fabricated for below ground installation and to meet or exceed an HS–20 wheel load.
>
> The plates forming the top and bottom of the vault shall be continuously welded on the interior by hand and continuously welded on the exterior by machine to form an air-tight seal.

The prefabricated steel vault shall be one complete unit when delivered to the installation location. Field welding of the entrance tube or any other parts will not be allowed. The manufacturer shall provide at least four 3/8 inch (9.5 mm) minimum thick lifting plates about the perimeter of the vault to ensure proper balance of the vault during the setting operation and to facilitate the lifting and handling of the station. Interior lifting eyes shall be placed over each piece of equipment in excess of 60 pounds (27.2 kg) in weight. Lifting eyes and connection shall be designed with a 25 percent safety factor. Any ferrous metal device passing through the walls shall be welded fully along its circumference or length on both sides of the vault wall. Non-ferrous, PVC, or ductile iron piping passing through the vault wall will be housed in a suitable ferrous metal wall sleeve. The sleeve shall be fully welded as described herein. The piping passing through the wall sleeve shall be sealed.

The attachment system shall, whenever possible, be factory installed. If because of shipping restrictions, the access hatch cannot be factory installed, field attachment is permitted only. The hatch drain shall be piped to the vault sump.

The access hatch shall be provided with keyed entry and hasp. The entry lock shall be flush mounted, protected from the elements by a cover skirt. The entry lock shall be of pin tumbler type, dead bolt, with an inside safety release. The Contractor shall coordinate with DWSD security to provide a standard #2246 DWSD master pad lock with two keys.

Data sheets detailing the access hatch and the attachment system shall be included in the manufacturer’s shop drawing submittal. If required to assure electrical continuity between the hatch and the remainder of the structure, the vault supplier shall provide a sufficient number of copper straps bonded to the structure and connected in accordance with the requirements of the selected cathodic protection system for the vault.

3.2.03 Access Ladder. An all fiberglass access ladder shall be provided in accordance with Master Specification Section 06550, FRP Ladders, Handrails, and Grating. The complete access ladder shall be bolted into place, at a minimum of 2 points both top and bottom, so as to be easily removable to facilitate equipment maintenance.

A ladder-up safety post shall be installed on the vertical centerline of the entrance ladder. The ladder-up safety post shall be spring balanced to move easily up and down and shall lock in the up position. The ladder-up safety post shall be made of steel of telescoping tubular section design. The up and down movement spring balance assembly shall be stainless steel.

3.2.04 Vault Insulation. Insulation shall comply with requirements of the Master Specification Section 07210, Thermal Protection and Building Insulation and the enclosed specification. The steel vault side wall, top and access hatch extension shall be insulated with a flame-retardant polyurethane foam insulating material. The insulation application around the hatch extension shall continue to the top of the attachment point of the hatch. The insulation shall be applied in a uniform thickness to the exterior of the vault by spray, or other approved methods. The insulation shall have a nominal minimum density of 2.0 PCF (32.0 kg per cu m) and shall be applied to the thickness required to achieve a minimum R value of 19. The insulation surface shall be fully protected and encapsulated by a water-resistant elastomeric membrane or other approved, water-resistant coating material, fully compatible with the foam insulation and suitable for below grade use. Foamed-in-place rigid insulation shall be as manufactured by North Carolina Foam Industries (NCFI), Energy Shield Incorporated or other approved. Nominal 1/8 inch (3.2 mm) protection board material, if required by system manufacturer, shall be provided to protect insulation and water-resistant coating prior to backfilling. Insulation coating shall be inspected prior to backfilling and be repaired, as necessary, to restore the water-resistant and thermal continuity of the system. All repairs shall be per insulation system manufacturer’s recommendations. Backfill shall be placed carefully to avoid damaging the insulation.

3.2.05 Corrosion Protection. The protective coating shall take place immediately after surface preparation. The protective coating shall be a 2 component, high solids, amide-cured epoxy system formulated for high build application having excellent chemical and corrosion-resistant properties. The epoxy system shall be self-priming and require no intermediate coatings. The protective coating shall provide, in not less than 2 applications, a high film build over welds, joints, bolts and sharp angles. The protective coating shall be applied as required to assure a dry film yield of no less than 4.0 mils (0.1 mm per application, with a total dry mil thickness of 8.0 mils (0.2 mm). If the specified dry mil thickness is not obtained with 2 coats, additional coats shall be applied.

All Metal Vaults should have a cathodic protection with anode alarm station and remote monitoring through computer control system in accordance with Master Specification Section 17100, Computer Control System.

Provide cathodic protection in accordance with Master Specification Section 13110, Cathodic Protection

3.2.06 Ventilation Equipment. The ventilation equipment shall draw air from outside the meter pit through a piping system and exhaust the air into the meter pit to provide ventilation. The fan shall be wired into the light switch so that when the lights are turned on, the fan will also turn on. The fan shall ventilate the pit to make it safe for personnel access. Installation shall include the ventilation system, including all equipment, piping, fittings, electrical, controls, devices, accessories, and appurtenances necessary for proper operation of the system. The ventilation system shall be approved by the engineer for the application.

Equipment furnished and installed shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer and the Engineer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer. All major items of mechanical equipment shall be of the best quality normally used for the purpose in good commercial practice and shall be the products of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a nameplate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable.

The ventilation fan shall be furnished and installed where indicated on the drawings. The ventilation fan shall be a factory-assembled and tested, centrifugal fan unit consisting of a housing, wheel, fan shaft, corrosion-resistant wall support structure, motor, and an inlet transition connection. An inlet pipe anti-vibration fitting shall be provided. The fan shall be direct drive. Fan parts in contact with airstream shall be fiberglass. The fan construction and materials shall be suitable for sewer gases and sub-zero Fahrenheit temperatures. The shaft and coupling shall have a guard that meets applicable safety regulations. A drain plug shall be provided on the bottom of the circular casing. All belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person may come in close proximity thereto shall be fully enclosed and properly guarded. The fan unit shall be provided with a fabricated wall support that resists and withstands corrosion.

The fan wheel shall be radial type, with a fastener to the shaft that can be disassembled, and reassembled. Each fan shall be factory test run and balanced. Vibration isolators, rubber-in-shear type, will be provided. The fan shall be tested and rated in accordance with AMCA Standard 210. The fan manufacturer shall provide the fan performance curve. The fan shall meet or exceed fire-rating standards per ASTM E84 test. The fan shall be wired in conjunction with the light switch so the light and ventilation fan operates simultaneously. After completion of the ventilation system, tests shall be conducted to demonstrate that each system is functioning in accordance with the specifications and to the satisfaction of the Engineer. If, upon testing, the fan does not meet all requirements of this specification, it shall be the obligation of the Contractor to make necessary modifications to bring the fan into compliance within ten days. No caulking of threaded joints or holes will be acceptable. The fan shall be Model 42-10-FE3 as manufactured by Hartzell Fan, Inc., Model FR-006 as manufactured by Duall Industries, Inc., or equal as approved by the engineer for the application. See drawings for complete details.

3.2.07 Lighting System. Lighting fixtures shall be furnished and installed as indicated on the drawings. Lamps shall be high efficiency, energy saving, of the same type as indicated in the fixture. The unit shall be an incandescent light fixture. The fixture accessories shall be high impact strength fiberglass reinforced polyester material with stainless steel hardware. The unit shall be fully enclosed, gasketed, vapor-tight and UL approved. It shall be complete with a glass heat resistant globe, die cast guard, and a 150-watt incandescent bulb. Manufacturers include Appleton, Crouse-Hinds, Hubbell or equal.

Fixtures shall be arranged in rows both vertically and horizontally to be clear of any obstructions. Fixtures shall be securely attached to mounting rails or plates, which are permanently attached to the vault ceiling or wall. Contractor shall furnish and install all bulbs for the entire lighting fixture installation and shall replace all burned out bulbs up to the time of final acceptance of the work.

Provide ten percent spare parts for light fixtures and lamps. Lighting shall also comply with Master Specification Section 16500, Lighting.

3.3 EXAMINATION. Verify that excavations are to required grade, dry, and not over excavated. Verify that concrete pad is of the required size and mass, and to the required elevation for proper vault installation.

3.3.01 Preparation. Remove scale and dirt, on inside and outside, before assembly. Prepare piping connections to equipment with flanges or unions.

3.3.02 Prefabrication. Fan, electrical controls, and accessories shall be factory installed as indicated on the Contract Drawings and shop drawings approved by the Engineer. Elements shall be supported with temporary supports until installed at site. All equipment, materials, and supplies shall be provided and installed in strict adherence with these specifications and Drawings, applicable codes, rules and regulations, and best current industry practice. After the steel has been completely installed underground including the electrical service and has been put in service by the installer, a factory service representative shall be scheduled to visit the job site and put the station into operation. The service representative shall be a regular employee of the vault manufacturer.

3.3.03 Installation. Install in accordance with manufacturer’s instructions and Master Specification Section 02211, Excavation, Filling and Grading. Provide non-conducting dielectric connections wherever jointing dissimilar metals. Route piping in orderly manner and maintain gradient. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Install bell and spigot pipe with bell end upstream. Install valves with stems upright or horizontal, not inverted. Provide magnetic locator markers 6 inches (15.2 cm) above (and directly over) each buried, cathodic protection anode.

3.3.04 Application. Use grooved mechanical couplings and fasteners only in accessible locations. Install all mechanical items in accordance with Master Specification Division 15000, Mechanical. Slope water piping and arrange to drain at low points.

End of Section

SECTION 13300

PRE-ENGINEERED PRECAST CONCRETE BUILDINGS

PART 1 - GENERAL

1.1 SCOPE. This section includes the manufacture and installation of pre-engineered prefabricated concrete buildings. They may arrive at the site pre-assembled or require erection. Pre-engineered pre-cast buildings shall be complete requiring only a foundation, electrical work and mechanical work to be a functional facility.

NOTE: BUILDINGS SPECIFIED ARE UNINSULATED

1.2 GENERAL.

1.2.01 Governing Standards.

AASHTO (American Association of State Highway and Transportation Officials)

ACI (American Concrete Institute) 318 - Building Code Requirements for Reinforced Concrete.

ACI 533 - Guide for Precast Concrete Wall Panels.

APA (Architectural Precast Association) and PCI (Precast/Prestressed Concrete Institute) Architectural Precast Concrete Color and Texture Selection Guide.

ASTM (American Society for Testing and Materials) A36 - Specification for Carbon Structural Steel.

ASTM A47 - Specification for Ferritic Malleable Iron Castings.

ASTM A123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

ASTM A153 - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A185 - Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

ASTM A283 - Specification for Low and Intermediate Tensile Strength

Carbon Steel Plates.

ASTM A307 - Specification for Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength.

ASTM A325 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

ASTM A416 - Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

ASTM A496 - Specification for Steel Wire, Deformed, for Concrete.

ASTM A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A5 ASTM 63 - Specification for Carbon and alloy Steel Nuts.

ASTM A572 - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

ASTM A666 - Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar.

ASTM A767 - Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

ASTM A934 - Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.

ASTM C33 - Specification for Concrete Aggregates.

ASTM C150 - Specification for Portland Cement.

ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.

ASTM C330 - Specification for Lightweight Aggregates for Structural Concrete.

ASTM C404 - Specification for Aggregates for Masonry Grout.

ASTM C494 - Specification for Chemical Admixtures for Concrete.

ASTM C979 - Specification for Pigments for Integrally Colored Concrete.

ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

ASTM C1240 - Specification for Silica Fume for Use in Hydraulic-Cement Concrete and Mortar.

ASTM D412 - Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension.

ASTM F593 - Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

AWS (American Welding Society) D1.1 - Structural Welding Code.

CCRL (Cement and Concrete Reference Laboratory)

CRSI (Concrete Reinforcing Steel Institute) Manual of Standard Practice.

Precast/Prestressed Concrete Institute (PCI) MNL 117 - Manual for Quality Control.

PCI MNL 120 - Design Handbook.

SSPC (Steel Structures Painting Council) Painting Manual.

AISC (American Institute of Steel Construction) Manual of Steel Construction

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Provide certification that welders to be employed in the Work are certified by AWS and applicable local building officials, and have been re-certified in the last 12 months.

1.3.02 Installer's Qualifications. Installer shall have a record of at least 5 years of successful installation of units similar to those required for this Project.

1.3.03 Fabricator's Qualifications. Firm shall have a minimum of 5 years experience in producing units similar to those required for this Project, with sufficient production capacity to produce and deliver required units without causing delay in the Work. Fabricating plant shall be certified by one of the following:

Architectural Precast Association (APA)

Precast/Prestressed Concrete Institute (PCI), Group A1

Applicable municipal building department

Firms not certified by APA or PCI shall submit a written Quality Assurance/Quality Control program for approval

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit shop drawings that show in-place location, fabrication details, plans, elevations, anchorages, reinforcement, connection details connection methods, dimensions, finishes, relationships to adjacent materials, erection and placement.

Include setting diagrams, templates, instructions and directions as required for installation. Also submit engineering calculations sealed by an engineer licensed to practice in Michigan. Provide reactions and all foundation loads required for the design of the building foundations.

Show identification marks, coordinated to Shop Drawings, and date of manufacture on all units to facilitate hauling and erection.

Submit proposed concrete mix design for each type and color of concrete mix required including backup mix.

Include color pigments, admixtures, steel primer and galvanized touch-up material.

1.4.02 Certifications. Submit Fabricator's certification from APA and PCI, or applicable municipal certification. Also submit Welders' AWS certification.

1.4.03 Samples. Submit 6 inch by 6 inch (15.3 cm by 15.3 cm) samples by appropriate thickness, for each type of unit and finished facing specified for approval of quality, color, and texture of surface finish. Submit prior to fabrication and show full range of color and texture.

1.4.04 Test Reports. Provide test reports on materials, compressive strength, and water absorption.

1.5 DELIVERY, STORAGE, AND HANDLING. Materials and equipment shall be adequately protected during all transportation, loading and unloading, storage, installation, and subsequent construction activities in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, parts, and Tools. Deliver building(s) to the Project site in such quantities and at such times to ensure continuity of installation but minimize job site storage. When job site storage is required, store in a manner to prevent physical damage and so that markings are visible.

Lift and support only at designated lifting or supporting points as shown on reviewed Shop Drawings.

1.6 WARRANTY. Provide a ten-year warranty to pre-engineered buildings in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The General Contractor shall furnish field measurements, if required, to precast fabricator.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Shall comply with Building Officials and Code Administrator Code (BOCA) National Building Code and the local municipal building codes, and regulations of other governing agencies having jurisdiction.

The facility shall be designed to withstand a roof load of 40 pounds per square foot in addition to piping, equipment or snow loads required by the building code.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable fabricators include Advanced Concrete Products Co.; Oldcastle Precast; ROMTEC Utilities; APS Concrete Products, Inc. or approved equal.

2.2 MATERIALS.

2.2.01 Concrete Materials.

Portland Cement	ASTM C 150, Type I or III, white or gray colors to achieve desired finish colors. Use only one brand, type, and color from the same mill. Gray cement may be used for non-exposed backup mixes.
Aggregates	ASTM C 33, gradation may differ to achieve desired finish characteristics. Select coarse and fine aggregate colors and screen sizes to match approved sample(s). Verify that adequate supply, from one pit or quarry, for each type of aggregate is available for the entire Project. If possible obtain entire aggregate supply prior to starting Work, or have aggregate supply held in reserve by aggregate supplier.
Lightweight aggregate	ASTM C 330

Water	Potable. Clean, clear, and free from deleterious amounts of salts, acids, alkalies, organic materials, oils, detergents, or other matter that may interfere with color, curing, or strength of concrete.
Admixtures	Select to be compatible in specified mix.
Air Entraining Admixture	ASTM C 260
Water Reducing Admixture	ASTM C 494, Type A, B, C, F, or G
Silica Fume	ASTM C 1240, for cement replacement for high performance concrete.
Coloring Agent	ASTM C 979, compatible with other concrete materials

2.2.02 Formwork. Provide forms with acceptable form facing materials that are non-reactive with concrete or form release agents and will produce required finish surfaces.

Construct and maintain forms to produce precast concrete units of shapes, lines, and dimensions indicated, within specified tolerances.

2.2.03 Reinforcing Materials.

Reinforcing Bars	ASTM A 615, Grade 40 or 60, unless otherwise required to meet structural requirements. (Use galvanized reinforcing bars; ASTM A 767, hot-dip galvanized where concrete cover is less than 1 1/2 inches (3.8 cm)). (Epoxy coated reinforcing bars, ASTM A 934, may be used in special applications.
Steel Welded Wire Fabric	ASTM A 185, plain, cold drawn
Pre-stressing Tendons	ASTM A 416, Grade 250 or 270, un-coated, 7 wire, low relaxation strand

2.2.04 Connection Materials.

Steel Shapes and Plates	ASTM A 36

Malleable Iron Castings	ASTM A 47
Carbon Steel Plates	ASTM A 283
High Strength, Low Alloy Structural Steel	ASTM A 572
Carbon Steel Structural Tubing	ASTM A 500, Grade B
Anchor Bolts	ASTM A 307, carbon steel or ASTM A 325, high strength; bolts, nuts, and washers
Welded Headed Studs	AWS D1.1, Type B
Deformed Steel Wire Bar Anchors	ASTM A 496
Stainless Steel Plate	ASTM F 593, Type 304 or Type 316; bolts and studs, nuts and washers)

2.2.05 Finish for Steel Connection Materials. Hot-dip galvanize (ASTM A 123 or A 153) steel exposed to weather in final assembly.

Shop Prime Remaining Steel Shapes	SSPC-Paint 25
Anchor Bolts, Nuts, Washers, Cadmium Plated	ASTM A 563, Grade C

Hot-dip galvanize (ASTM A 153) setting bolts or projecting steel in masonry applications.

Galvanizing Repair Paint	DOD-P-21035A or SSPC-Paint 20
Welding Electrodes	Comply with AWS Standards

2.2.06 Grout Materials.

Cement Grout	Cement ASTM C 150; sand ASTM C 404; proportions 1:2.5 by volume, minimum water for placement and hydration.

Non-Shrink Grout	ASTM C 1107
Epoxy Grout	Consult suppliers

2.3 MIXES. Design mixes for each type of concrete specified shall be prepared by an independent testing agency or by architectural precast manufacturing plant personnel at precast fabricator's option.

Proportion mixes by either testing agency trial batch or field test data methods in accordance with ACI 211.1, using materials to be used on the Project, to provide normal weight concrete. Compressive Strength shall be 5,000 psi (or other strength requirement) when tested in accordance with ASTM C 39. Cement content shall be not less than 5 1/2 sacks per cubic yard.

Maximum water cement ratio shall be 0.40 at point of placement.

Add air-entrainment admixture to result in air content at point of placement complying with ACI 533 requirements, but in any case not less than 4.5 percent.

Water absorption shall be a maximum 6% (by weight) when tested in accordance with ASTM C 642.

2.4 MANUFACTURE AND FABRICATION. Fabricate precast concrete units with manufacturing, curing, testing procedures, quality control recommendations, and dimensional tolerances as specified in ACI 533, unless more stringent requirements are shown or specified.

Fabricate units straight, smooth and true to size and shape, with exposed edges and corners precise and square, unless otherwise indicated.

2.4.01 Openings. Cast openings larger than 10 inches (25.4 cm) in any dimension according to locations shown on Shop Drawings. Smaller holes may be field cut when approved by Engineer.

2.4.02 Reinforcement. Comply with CRSI "Manual of Standard Practice" and ACI 318 recommendations. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses, and to comply with specified performance criteria.

2.4.03 Cast-In Items. Provide embedded anchors, inserts, steel shapes, and lifting devices as shown on reviewed

Comply with ACI-533 requirements for measuring, mixing, transporting, and placing concrete. Place facing mix to a thickness of the greater of 1 inch (2.5 cm) or 1.5

times the maximum aggregate size. Place back-up concrete to ensure bond with face concrete.

Consolidate concrete using equipment and procedures complying with ACI 533.

Permanently mark units with pick-up points as shown on reviewed Shop Drawings. Imprint casting date and piece mark on a surface to be concealed from view in the finished structure.

Cure concrete in accordance with ACI 533 requirements.

Discard units that are warped, cracked, broken, spalled, stained, or otherwise defective unless repairs are approved by the Engineer and meet specified requirements. Refer to ACI 533 for product finish requirements unless otherwise shown or specified.

2.4.04 Fabrication Tolerances. Fabricate to tolerances listed in ACI 533.

2.5 FINISHES. Finish shall be selected by the Engineer based on submittal prepared using APA and PCI “Architectural Precast Concrete Color and Texture Selection Guide”. Visible bugholes shall not be acceptable. Finish exposed back surface of units by smooth steel trowel finish.

2.6 SOURCE QUALITY CONTROL. Inspect and test architectural precast concrete in accordance with ACI 533. Producers certified by APA or PCI may conduct their own Quality Control operations with reports to designated authorities.

Non-certified producers shall furnish and pay for reports by an independent Testing Laboratory, approved by the Owner.

The Owner may retain an independent Testing Laboratory to evaluate fabricator’s quality control and testing methods. Testing Laboratory shall be certified by CCRL or similar national authority. Fabricator shall allow Testing Laboratory access to all operations pertinent to the Project.

2.6.01 Defective Work. Buildings that are damaged shall be repaired to the satisfaction of the Engineer or replaced.

PART 3 - EXECUTION

3.1 INSPECTION. Examine substrates and conditions for compliance with requirements for installation, tolerances, true and level bearing surfaces, and other conditions affecting performance of architectural precast concrete units.

Do not proceed with installation until unsatisfactory conditions have been corrected. Do not install units until supporting structure has been completed (has attained minimum allowable design compressive strength).

If pre-cast building is pre-fabricated and pre-assembled, inspect the building for quality of assembly and measure that all the walls and roof are true and fit together well. Check for change.

3.2 INSTALLATION.

3.2.01 Erection. Erection shall be by contractor experienced and trained in placement and securing of architectural precast concrete units. Lift and handle precast using lift points and embeds as shown on precast shop drawings.

Erect level, plumb, and true to line within tolerances listed in ACI-533. Do not allow cumulative dimensional errors to develop. Adjustments such as shimming which would place additional stress on units will not be permitted. Adhere to dimensional tolerances in accordance with PCI recommendations. Erect and secure in a manner to prevent damage to units or units in place. Replace any damaged units.

Use joint sealants as specified in Master Specification Section 07600, Caulking and Sealers. Where two stage joint seal is required, sequence with sealant applicator to ensure that sealant, gaskets, and similar items required for interior side seal are installed concurrently with installation of precast units.

3.2.02 Repair. When approved by Engineer, repair exposed surfaces of units to match color, texture, and uniformity of surrounding units. Remove and replace damaged units when repairs do not meet requirements.

3.2.03 Protection. Protect finished surfaces from soiling or damage.

3.2.04 Cleaning. Clean exposed surfaces of units after erection if soiled or stained. Wash and rinse according to precast concrete fabricator's recommendations. Protect other Work from damage while cleaning.

Do not use cleaning materials or methods that change the appearance of architectural precast concrete finishes. Test clean a small area to verify adequacy and safety of materials and methods.

Leave in condition for application of items in Master Specification Division 7, Thermal and Moisture Protection.

End of Section

SECTION 13400

PRECAST CONCRETE VAULTS, METER PITS, AND OTHER UNITS

PART 1 - GENERAL

1.1 SCOPE. This specification covers the materials for and manufacture of precast, reinforced concrete vaults, meter pits, and other units produced in accordance with the plans and these specifications.

1.2 GENERAL.

1.2.01 Standards. Where applicable, the latest editions of the following standards shall be considered a part of these specifications. In case of conflict, these specifications shall take precedence over the listed standard.

AASHTO (American Association of State Highway and Transportation Officials) "Standard Specification for Highway Bridges".

AASHTO "Guide Specifications for Structural Design of Sound Barriers".

ACI (American Concrete Institute) 318 "Building Code Requirements for Reinforced Concrete".

ASTM (American Society for Testing and Materials) C478 "Specification for Precast Reinforced Concrete Manhole Sections".

ASTM C1433 - "Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers".

ASTM C825 "Specification for Precast Concrete Barrier".

ASTM C850 "Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft Cover Subjected to Highway Loadings".

ASTM C858 "Specification for Underground Precast Concrete Utility Structures".

ASTM C890 "Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures".

ASTM C913 "Specification for Precast Concrete Water and Wastewater Structures".

ASTM C915 "Specification for Precast Reinforced Concrete Crib Wall Members".

ASTM C923 "Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals".

ASTM C936 "Specification for Solid Concrete Interlocking Paving Units".

ASTM C990 "Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants".

ASTM C1227 "Specification for Precast Concrete Septic Tanks".

AWS (American Welding Society) Structural Welding Code - Structural Steel AWS D1.1.

AWS Structural Welding Code – Reinforcing Steel AWS D1.4.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer’s Qualifications. The Precaster shall have been in the business of producing precast concrete products similar to those specified for a minimum of 5 years. Precaster shall demonstrate adherence to the standards set forth in the National Precast Concrete Association Quality Control Manual and shall maintain a permanent quality control department or retain an independent testing agency on a continuing basis. The agency shall issue a report, certified by a licensed engineer, detailing the ability of the Precaster to produce quality products consistent with industry standards.

1.3.02 Testing. The Precaster shall show that the following tests are performed in accordance with the ASTM standards indicated. Tests shall be performed for each 150 cu. yd. (115 cu. m) of concrete placed, but not less frequently than once per structure and per week.

Slump	C143
Compressive Strength	C31, C192, C39
Air Content (when air-entrained concrete is being used)	C231 or C 1 73
Unit Weight	C138

The Precaster shall provide documentation demonstrating compliance with this section.

The Owner may place an inspector in the plant when the products covered by this specification are being manufactured.

1.3.03 Clearances. All clearances as identified on standard meter pit drawings around equipment, valves, fittings and materials unless otherwise directed by Engineer.

1.4 SUBMITTALS

1.4.01 Drawings and Data. For standard units, the Precaster will supply cut sheets showing conformance to project drawings and requirements and applicable ASTM specifications listed in this specification. The Precaster shall certify that such products will meet the ASTM specifications.

For custom-made units, the plans for precast concrete units shall be shop drawings furnished by the Precaster for approval by the Engineer. These drawings shall show complete design, installation, and construction information in such detail as to enable the Engineer to determine the adequacy of the proposed units for the intended purpose. Details of steel reinforcement size and placement and supporting design calculations shall be included. The drawings shall include a schedule that will list the size and type of precast concrete unit at each location where the units are to be used. The precast concrete units shall be produced in accordance with drawings. All design calculations shall be performed by, and certified by, an engineer registered in the State of Michigan.

The size of the Vaults, Meter Pits shall be in accordance with site conditions and per requirements of Great Lakes Water Authority (GLWA) Meter Operations.

1.4.02 Certifications. The Precaster shall provide proof of certification by the National Precast Concrete Association's Plant Certification Program prior to and during production of the products for this project.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Handling. Products shall be stored, handled and shipped in a manner to minimize damage. Lifting holes or inserts shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for the purpose of handling.

1.5.02 Minimum Strength. Products shall not be shipped until they are at least 5 days old, unless it can be shown that the concrete strength has reached at least 75% of the specified 28-day strength, or that damage will not be caused which will impair the performance of the product.

1.5.03 Acceptance. Final inspection and acceptance of the precast concrete products shall be made by the Engineer upon arrival at the job site.

1.6 WARRANTY. Provide all warranties in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 – PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS.

Precast reinforced concrete vaults, meter pits, and other underground enclosures shall be designed and fabricated to withstand the following conditions as appropriate.

Design Criteria	Live Load	30% Impact Factor	AASHTO & ASTM C857 Design Load	Load Area
Pedestrian (Areas such as sidewalks, terraces, & other areas which do not receive vehicular traffic)	350 psf (1709 kg/sq m)	N.A.	N.A.	
Incidental Traffic (AASHTO H-10, Wheel load to be used in driveways, parking lots, right of ways, & other areas of incidental vehicular traffic)	8,000 lbs (3,629 kg)	10,400 lbs (4,717 kg)	22,568 lbs (10,237 kg)	10” x 10” (25.4 cm x 25.4 cm) Placed at any location on the roof
Roadway Traffic (AASHTO H-20 or HS-20, Wheel load to be used in traffic way)	16,000 lbs (7,258 kg)	20,800 lbs (9,435 kg)	45,135 lbs (20,473 kg)	8” x 20” (20.3 cm x 50.8 cm)

Horizontal loading shall be based on available soil data, but in any case shall be no less than an equivalent fluid weighing 60 pounds per cubic foot in addition to live loads from the above table. Vaults, Meter Pits, and other underground enclosures shall be designed to withstand a minimum H 20 Class Loading.

2.2 MATERIALS.

2.2.01 Concrete. Raw materials for concrete shall meet the following standards.

Portland Cement	ASTMC150, Type I, II, III or V

Aggregates	ASTM C33 or C330
Water	Potable or free of deleterious substances in amounts harmful to concrete or embedded metals
Air-entraining Admixtures	ASTM C260
Water reducing, retarding, accelerating, high range water reducing Admixtures	ASTM C494
Pozzolans, fly ash and other mineral admixtures	ASTM C618
Ground granulated blast furnace slag Admixtures	ASTM C989

2.2.02 Reinforcing Steel. Concrete reinforcement shall be steel bars or welded wire fabric, or a combination. Reinforcement shall meet the following standards:

Deformed Billet-steel Bars	ASTM A615
Deformed Rail-steel Bars	ASTM A616
Deformed Axle-steel Bars	ASTM A617
Deformed Low-alloy steel Bars	ASTM A706
Plain Wire	ASTM A82
Deformed Wire	ASTM A496
Plain Wire	ASTM Al 85
Deformed Wire Welded Wire Fabric	ASTM A497
Epoxy Coated Reinforcing Bars	ASTM A775
Epoxy Coated Wire and Fabric	ASTM A884
Galvanized Reinforcing Bars	ASTM A7673.3

2.2.03 Inserts and Embedded Metal. All items embedded in concrete shall be of the type required for the intended task, and meet the following standards:

Structural steel plates, angles, etc	ASTM A36

Welded studs	AWS DI. 1

2.2.04 Finishes (as required).

Shop primer	Manufacturers' standards
Hot-dipped galvanized	ASTM A152
Zinc-rich coating	MIL-P-2135 self-curing, one component, sacrificial

2.2.05 Joint Sealant and Joint Gaskets.

Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets	ASTM C443
External Sealing Bands for Noncircular Sewer, Storm Drain, and Culvert Pipe	ASTM C877
Joints for Concrete Pipe, Manholes, and Manufactured Box Sections Using Preformed Flexible Joint Sealants	ASTM C990
Specification for Elastomeric Joint Sealant	ASTM C920

2.2.06 Pipe Entry Connectors.

Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals	ASTM C923

2.2.07 Grout.

Cement grout	Portland cement with enough water for the required strength and sand for proper consistency. May contain mineral or chemical admixtures, if approved by Owner's representative
Non-shrink grout	Premixed, packaged expansive and non-expansive shrink resistant grout.

2.3 CONCRETE MIXES.

2.3.01 Mix Proportions. Mix proportions shall be determined by following the standards in ACI 318 Chapter 5.

Recommendations for selecting proportions for concrete are given in detail in "Standard Practice, for Selecting Proportions for Normal, Heavyweight, and Mass Concrete" (ACI 21 1.1). Recommendations for lightweight concrete are given in "Standard Practice for Selecting Proportions for Structural Lightweight Concrete" (ACI 211.2).

2.3.02 Water-Cement Ratio and Air Content. Concrete that will be exposed to freezing and thawing shall contain entrained air and shall have water-cement ratios of 0.45 or less. Concrete which will not be exposed to freezing, but which is required to be watertight, shall have a water-cement ratio of 0.50 or less if the concrete is exposed to fresh water, or 0.45 or less if exposed to brackish water or sea water. For corrosion protection, reinforced concrete exposed to deicer salts, brackish water or sea water shall have a water-cement ratio of 0.40 or less. Cement content shall be no less than 6 sacks per cubic yard.

The air content of concrete that will be exposed to freezing shall be within the limits shown below.

Content For Frost-Resistant Concrete		
	Air Content, %*	
Aggregate Size	Severe Exposure	Moderate Exposure
3/8 in (9.5 mm)	6.0 to 9.0	4.5 to 7.5
1/2 in (12.7 mm)	5.5 to 8.5	4.0 to 7.0
3/4 in (19.1 mm)	4.5 to 7.5	3.5 to 6.5
1 in (2.5 cm)	4.5 to 7.5	3.0 to 6.0
1 1/2 in (3.8 cm)	4.0 to 7.0	3.0 to 6.0

*For specified compressive strengths greater than 5000 psi (34.5 MPa), air content may be reduced 1 percent.

2.3.03 Compressive Strength. All concrete shall develop a minimum compressive strength of 4000 psi (27.6 MPa) in 28 days unless other strengths are designated on the drawings.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Forms. Forms for manufacturing precast concrete products shall be of the type and design consistent with industry standards. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that no product damage shall be caused by the forces and vibrations to which the forms will be subjected. Forms shall be cleaned of concrete buildup after each use. Coating of form release agents shall not be allowed to build up.

2.4.02 Reinforcement. Cages of reinforcement shall be fabricated either by tying the bars, wires or welded wire fabric into rigid assemblies or by welding where permissible in accordance with AWS D 1.4.

Reinforcing shall be positioned as specified by the design and so that the concrete cover conforms to requirements. The tolerance on concrete cover shall be one-third of that specified but not more than 1/2 inch (12.7 mm). Concrete cover shall not be less than 1 1/2 inch (12.7 mm). Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations.

2.4.03 Embedded Items. Embedded items shall be positioned at locations specified in the design documents. Inserts, plates, weldments, lifting devices and other items to be imbedded in precast concrete products shall be held rigidly in place so that they do not move significantly during casting operations.

2.4.04 Placing Concrete. Concrete shall be deposited into forms as near to its final location as practical. The free fall of the concrete shall be kept to a minimum and in any case shall not exceed 5 feet (1.5 m).

Concrete shall be consolidated in such a manner that segregation of the concrete is minimized and honeycombed areas are kept to a minimum. Vibrators used to consolidate concrete shall have frequencies and amplitudes sufficient to produce well-consolidated concrete.

2.4.05 Cold Weather Requirements. Recommendations for cold weather concreting are given in detail in "Cold Weather Concreting" reported by ACI Committee 306.

Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing weather.

All concrete materials and all reinforcement, forms, fillers, and ground with which concrete is to come in contact shall be free from frost.

Frozen materials or materials containing ice shall not be used.

Freshly constructed units shall be protected from freezing until the concrete has attained its design 28 day strength.

2.4.06 Hot Weather Requirements. Recommendations for hot weather concreting are given in detail in "Hot Weather Concreting" reported by ACI Committee 305.

During hot weather, proper attention shall be given to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation that could impair required strength or serviceability of the member or structure.

2.4.07 Curing by Moisture Retention. Moisture shall be prevented from evaporating from exposed surfaces until adequate strength for stripping is reached by one of the following methods:

> Cover with polyethylene sheets a minimum of 6 mils (6 x (.001 x 25.4 mm) thick.
>
> Cover with burlap or other absorptive material and keep continually moist.
>
> Curing compounds applied at a rate not to exceed 200 sq. ft. per gallon (52.3 sq. m per liter) or per manufacturer's recommendations.

Surfaces that will be exposed to weather during service shall be cured as above a minimum of 3 days. Forms shall be considered effective in preventing evaporation from the contact surfaces. If air temperature is below 50 degrees F (10 degrees C) the curing period shall be extended.

2.4.08 Curing with Heat and Moisture. Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. Steam, if used, shall be applied within a suitable enclosure, which permits free circulation of the steam. If hot air is used for curing, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 160 degrees F (71.1 degrees C). These requirements do not apply to products cured with steam under pressure in an autoclave.

2.4.09 Finishes for Standard Formed Surfaces. Surfaces cast against approved forms using industry practice in cleaning forms, designing concrete mixes, placing and curing concrete. Normal color variations, form joint marks, small surface holes caused by air bubbles, and minor chips and spills will be tolerated but no major imperfections, honeycombs or other defects will be permitted.

2.4.10 Finishes for Standard Unformed Surfaces. Surfaces finished with a vibrating screen, or by hand with a float. Normal color variations, minor indentations, minor chips and spills will be tolerated but no major imperfections, honeycombs, or other defects shall be permitted.

2.4.11 Special Finishes. Troweled, broomed or other finishes shall be according to the requirements of project documents and performed per industry standards or supplier specifications.

Precasters shall submit sample finishes for approval when required by the project documents. The sample finishes shall be approved prior to the start of production.

2.4.12 Stripping Products from Forms. Products shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by the design. If no such requirement exists, products may be removed from the forms after the final set of concrete provided that stripping damage is avoided.

2.4.13 Patching and Repairs. No repair is required to formed surfaces which are relatively free of air voids and honeycombed areas, unless the surfaces are required by the design to be finished.

2.4.14 Repairing Minor Defects. Defects that will not impair the functional use or expected life of a manufactured precast concrete product may be repaired by any method, which does not impair the product.

2.4.15 Repairing Honeycombed Areas. When honeycombed areas are to be repaired, all loose material shall be removed and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. If a proprietary repair material is not used, the area shall be saturated with water and, immediately prior to repair, the area should be damp, but there should not be excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

2.4.16 Repairing Major Defects. Defects in precast concrete products which impair the functional use or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

2.5 ACCESSORIES.

2.5.01 Access Hatch. The access hatch shall consist of a Bilco Type J or S steel access hatch, or equal as specified in Master Specification Section 05630, Access Hatches. Size shall be as shown on the Drawings. All access hatches for vaults shall be designed to support an H-20 wheel load. A flashing system clip shall be provided on the outside of the vault that shall lip the top of the riser with insulation. The flashing clip shall be fastened watertight to the riser flange so the insulation remains dry under all conditions.

The access hatch attachment system shall include but not be limited to 10 - 1/4 inch (6.4 mm) diameter stainless steel flange bolts with nuts and 2 flat washers each, bedding compound sealant, 4504 Scotch polyfoam and single side adhesive coated 1/4 inch (6.5 mm) by 3 inch (7.6 cm) gasket materials.

The access hatch shall be provided with keyed entry and hasp. The entry lock shall be flush mounted, protected from the elements by a cover skirt. The entry lock shall be of pin tumbler type, dead bolt, with an inside safety release. The Contractor shall coordinate with DWSD security to provide a standard #2246 DWSD master pad lock with two keys.

2.5.02 Access Ladder. An all fiberglass access ladder shall be provided in accordance with Master Specification Section 06550, FRP Ladders, Handrails, and Grating. The complete access ladder shall be bolted into place, at a minimum of 2 points both top and bottom, so as to be easily removable to facilitate equipment maintenance.

A ladder-up safety post shall be installed on the vertical centerline of the entrance ladder. The ladder-up safety post shall be spring balanced to move easily up and down and shall lock in the up position. The ladder-up safety post shall be made of steel of telescoping tubular section design. The up and down movement spring balance assembly shall be stainless steel.

2.5.03 Ventilation Equipment. The ventilation equipment shall draw air from outside the meter pit through a piping system and exhaust the air into the meter pit to provide ventilation. The fan shall be wired into the light switch so that when the lights are turned on, the fan will also turn on. The fan shall ventilate the pit to make it safe for personnel access. Installation shall include the ventilation system, including all equipment, piping, fittings, electrical, controls, devices, accessories, and appurtenances necessary for proper operation of the system. The ventilation system shall be approved by the engineer for the application.

Equipment furnished and installed shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer and the Engineer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer. All major items of mechanical equipment shall be of the best quality normally used for the purpose in good commercial practice and shall be the products of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a nameplate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable.

The ventilation fan shall be furnished and installed where indicated on the drawings. The ventilation fan shall be a factory-assembled and tested, centrifugal fan unit consisting of housing, wheel, fan shaft, corrosion-resistant wall support structure, motor, and an inlet transition connection. An inlet pipe anti-vibration fitting shall be provided. The fan shall be direct drive. Fan parts in contact with airstream shall be fiberglass. The fan construction and materials shall be suitable for sewer gases and sub-zero Fahrenheit temperatures. The shaft and coupling shall have a guard that meets applicable safety regulations. A drain plug shall be provided on the bottom of the circular casing. All belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person may come in close proximity thereto shall be fully enclosed and properly guarded. The fan unit shall be provided with a fabricated wall support that resists and withstands corrosion.

The fan wheel shall be radial type, with a fastener to the shaft that can be disassembled, and reassembled. Each fan shall be factory test run and balanced. Vibration isolators, rubber-in-shear type, will be provided. The fan shall be tested and rated in accordance with AMCA Standard 210. The fan manufacturer shall provide the fan performance curve. The fan shall meet or exceed fire-rating standards per ASTM E84 test. The fan shall be wired in conjunction with the light switch so the light and ventilation fan operates simultaneously. After completion of the ventilation system, tests shall be conducted to demonstrate that each system is functioning in accordance with the specifications and to the satisfaction of the Engineer. If, upon testing, the fan does not meet all requirements of this specification, it shall be the obligation of the Contractor to make necessary modifications to bring the fan into compliance within ten days. No caulking of threaded joints or holes will be acceptable. The fan shall be Model 42-10-FE3 as manufactured by Hartzell Fan, Inc., Model FR-006 as manufactured by Duall Industries, Inc., or equal as approved by the engineer for the application. See drawings for complete details.

2.5.04 Lighting System. Lighting fixtures shall be furnished and installed as indicated on the drawings. Lamps shall be high efficiency, energy saving, of the same type as indicated in the fixture. The unit shall be an incandescent light fixture. The fixture accessories shall be high impact strength fiberglass reinforced polyester material with stainless steel hardware. The unit shall be fully enclosed, gasketed, vapor-tight and UL approved. It shall be complete with a glass heat resistant globe, die cast guard, and a 150-watt incandescent bulb. Manufacturers include Appleton, Crouse-Hinds, Hubbell or equal.

Fixtures shall be arranged in rows both vertically and horizontally to be clear of any obstructions. Fixtures shall be securely attached to mounting rails or plates, which are permanently attached to the vault ceiling or wall. Contractor shall furnish and install all bulbs for the entire lighting fixture installation and shall replace all burned out bulbs up to the time of final acceptance of the work.

Provide ten percent spare parts for light fixtures and lamps. Lighting shall also comply with Master Specification Section 16500, Lighting.

2.5.05 Application. Install all mechanical items in accordance with Master Specification Division 15000, Mechanical. Slope water piping and arrange to drain at low points.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Site Access. Engineer shall be responsible for providing adequate access to the site to facilitate hauling, storage and proper handling of the precast concrete products.

3.1.02 Placement. Precast concrete products shall be installed to the lines and grades shown in the contract documents or otherwise specified. Products shall be lifted by suitable lifting devices at points provided by the Precaster. Products shall be installed per the Precaster's recommendation.

3.1.03 Installation of Small Boxes Subject to Incidental Traffic. Prepare the excavation approximately 6 inches (15.2 cm) deeper than the overall height of the overall height of the enclosure. The length and width of the excavation should be determined by adding 4 to 6 inches (10.2 to 15.2 cm) to the overall length and width of the box.

Place approximately 3 to 6 inches (7.6 to 15.2 cm) of compacted material such as sand or gravel. Gravel is the recommended material because of its drainage characteristics. The compacted material shall be leveled so the top of the box is flush to grade.

Place select backfill into the excavation at 12 inch (30.5 cm) lifts and compact either by mechanical compaction or flooding. The backfill shall be discontinued approximately 8 inches (20.3 cm) below finished grade. The final 8 inches (20.3 cm) of the excavation shall be finished with concrete.

3.1.04 Watertightness. Where watertightness is a necessary performance characteristic of the precast concrete product's end use, watertight joints, connectors and inserts shall be used to ensure the integrity of the whole system.

3.1.05 Testing. When testing is required for an underground product, one of the following methods shall be followed:

Vacuum testing prior to backfill according to ASTM C 1 244.

Water testing according to contract documents and Precaster's recommendations.

3.1.06 Equipment Placement. Contractor shall place all equipment, valves, fittings and materials in accordance with clearances identified on standard meter pit drawings unless otherwise directed by Engineer.

End of Section

SECTION 13500

INFORMATION DATA CENTERS

PART 1 - GENERAL

1.1 SCOPE. This section identifies the standards for installation of raised floor systems and accessories for Information Data Centers. It includes floor support framing systems, removable floor panels, fascia panels, plenum dividers, grilles, ramps, stairs, railings, and system electrostatic grounding.

1.2 GENERAL.

Governing Standards. (Unless otherwise noted the current edition of the following standards shall be referenced).

American National Standards Institute (ANSI) A208.1Particleboard Mat formatted Woods.

American Society for Testing and Materials (ASTM) ASTM E 84Surface Burning Characteristics of Building Materials.

ASTM E 648Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.

Ceiling and Interior Systems Contractors Association (CISCA) CISCA Access FloorsRecommended Test Procedures for Access Floors.

Department of Commerce (DOC) DOC PS 1Voluntary Product Standard - Construction and Industrial Plywood.

Federal Specifications (FS) FS SS-T-312(Rev B; Int Am 1; Notice 2; Canc. Notice 1) Tile, Floor: Asphalt, Rubber, Vinyl, and Vinyl Composition.

International Conference of Building Officials (ICBO) ICBO Bldg CodeUniform Building Code (3 Vol.).

National Electric Manufactures Association (NEMA) NEMA LD 3(High-Pressure Decorative Laminates.

National Fire Protection Association (NFPA) 75Protection of Electronic Computer/Data Processing Equipment.

NFPA 99Health Care Facilities.

Underwriters Laboratories (UL) 779Electrically Conductive Floorings.

1.3 QUALITY ASSURANCE.

1.3.01 Manufacturer Qualifications. The manufacturer shall be a company specializing in manufacturing products specified in this section with minimum five years experience.

1.3.02 Installer Qualifications. The installer shall be a company specializing in performing work of this section with minimum five years experience and certified by manufacturer.

1.3.03 Testing. Raised flooring shall be factory tested by an independent laboratory at the same position and maximum design elevation and in the same arrangement as shown on the drawings for installation so as to duplicate service conditions as much as possible.

Floor panel, stringer, and pedestal load testing shall be conducted in accordance with CISA Access Flooring Standards.

Test factory installed floor covering for bond strength. The test panel shall be supported on pedestals and stringers as specified for the installed floor. The supports shall be braced as necessary to prevent sideways movement during the test. A test load of 1000 pounds (4.45 kN) shall be imposed on the test assembly through a hard plastic caster 3 inches (75 mm) in diameter and 1 inch (25 mm) wide. The caster shall be rolled completely across the center of the panel. The panel shall withstand 20 passes of the caster with no delamination or separation of the covering.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit drawings showing layout of the work, sizes and details of components, details at floor perimeter, bracing to resist seismic or other lateral loads, typical cutout details including size and shape limitation, method of grounding, description of shop coating, and installation height above structural floor.

Submit manufacturer's descriptive data, catalog cuts, and installation instructions. The data shall include information about any design and production techniques, procedures and policies used to conserve energy, reduce material, improve waste management or incorporate green building/recycled products into the manufacturer of their components or products. Cleaning and maintenance instructions shall be included.

Submit design calculations which demonstrate that the proposed floor system meets Building Code requirements for seismic and floor loading. Certified copies of test reports may be submitted in lieu of calculations.

1.4.02 Certificates. Submit certificate of compliance attesting that the raised floor system meets specification requirements.

1.4.03 Samples. Submit one sample of each panel type and suspension system proposed for use.

1.4.04 Test Reports. Submit certified copies of test reports from an approved testing laboratory, attesting that the proposed floor system components meet the performance requirements specified. Submit test results for testing of electrical resistance.

1.5 DELIVERY, STORAGE, AND HANDLING. Materials shall be stored in original protective packaging in a safe, dry, and clean location and shall be handled in a manner to prevent damage. Panels shall be stored at temperatures between 40 and 90 degrees F (4 and 32 degrees C), and between 20 percent and 70 percent humidity.

1.6 WARRANTY. Submit a written 1-year warranty from date of occupancy, executed by Contractor and Manufacturer, agreeing to repair or replace units that fail in materials or workmanship within the specified warranty period. Failures include, but are not necessarily limited to, structural failures including excessive deflection, excessive marring, scratching, chipping or other damage to flooring surface. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under the Contract Documents.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Raised floor systems must be designed to accommodate static, rolling and impact loading. There are three types of flooring installations:

> Type I Raised floors completely surrounded by building walls. These are the most resistant to seismic loadings.
>
> Type II Raised floors with part of the edge exposed and not restrained by other structural elements. Type II floors are less resistive to seismic loadings along the axis of the unconstrained side. Seismic loadings can be resisted by securing the perimeter panels of all floors to the supporting structural framing and fitting the panels tightly together, or by cross bracing

the structural frame to resist overturning.

Type III Raised floors are free standing without lateral contact with other structural elements. Type III floors are primarily strengthened with cross bracing to resist loads defined by the UBC Buildings not excluded by TI 800-01 Design Criteria will be accessible in accordance with 36 CFR, Part 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities.

Raised flooring support systems are available as either a stringer or stringerless system. A stringer is a horizontal framing member that connects the pedestal head, supports the panel edges and adds lateral stability to the floor system. Stringers shall be used on all systems with a height that exceeds 12 inches (300 mm) or if the total area is over 4000 square feet (371 square meters) unless the system provides bolted connection between the panel and pedestal.

The metropolitan Detroit Area is in Seismic Design Category A as defined by the International Building Code 2000. Refer to Section 1614 of the IBC for additional information.

2.1.01 Floor Panels. Floor panel testing shall be conducted in accordance with CISCA Access Floors Standard. When tested as specified, all deflection and deformation measurements shall be made at the point of load application on the top surface of the panel. Floor panels shall be capable of supporting 1000 pounds (4450 N) concentrated load without deflecting more than 0.080 inch (2.03 mm) and without permanent deformation in excess of 0.010 inch (0.25 mm) in any of the specified tests. Floor panels shall be capable of supporting 250 pounds per square foot (11.97 KPa per square meter uniform) live load without deflection more than 0.040 inch (1.02 mm). Floor panels shall be capable of supporting 600 pounds (2670 N) rolling load without deflecting more than 0.040 inch (1.02 mm) and without permanent deformation in excess of 0.020 inch (0.51 mm). In accordance with CISCA Access Floors Standard, the permanent deformation limit under rolling load shall be satisfied in all of the specified tests.

2.1.02 Stringers. Stringers shall be capable of supporting a 250 pound (1110 N) concentrated load at mid span without permanent deformation in excess of 0.010 inch (0.25 mm).

2.1.03 Pedestals. Pedestals consist of a base plate, post and an adjustable head, and are available in heights from 6 inches (150 mm) to 96 inches (2400 mm). Pedestals 24 inches (600 mm) high or higher shall be securely anchored to the structural floor in addition to being held in place by adhesive. Pedestals are normally held in place with an adhesive and shall be in full contact with the sub floor surface.

Pedestals shall be capable of supporting a 5000-pound (22.24 kN) axial load without permanent deformation.

2.1.04 Pedestal Adhesive. Adhesive shall be capable of securing a pedestal in place with sufficient bonding strength to resist an overturning force of 1000 inch-pounds (113 Nm).

2.1.05 Bond Strength of Factory Installed Floor Covering. Bond strength of floor covering shall be sufficient to permit handling of the panels by use of the panel lifting device, and to withstand moving caster loads up to 1000 pounds (4.45 kN), without separation of the covering from the panel.

2.1.06 Leakage. If the space below the finished floor is to be an air plenum, air leakage through the joints between panels and around the perimeter of the floor system shall be measured. The air leakage shall not exceed 0.1 cubic foot/minute/linear foot (0.15 L/s/linear meter) of joint when subjected to 0.1 inch (2.5 mm) water gauge positive pressure in the plenum.

2.1.07 Grounding. The raised floor system shall be grounded for safety hazard and static suppression.

2.2 FLOOR PANELS. There are five basic floor panel types: aluminum, hollow formed steel, metal-clad cementitious fill, metal-clad wood core, and concrete. Nonferrous materials shall be used in areas where there is potential for damage by rust oxides or paint flakes. In accordance with CISCA Test Method, hollow panels shall have a safety factor of 2 and filled panels a safety factor of 3 in terms of ultimate load.

Except for edge panels, panel size shall be 24 by 24 inches (600 by 600 mm). Finished panels shall be within a 0.010 inch (0.25 mm) tolerance of the nominal size, and shall be square within a tolerance of 0.015 inch (0.38 mm) measured corner-to-corner. The top surface of panels shall be flat within a 0.020 inch (0.51 mm) tolerance measured corner-to-corner. Panels shall be permanently marked to indicate load rating and model number.

2.2.01 Aluminum Panels Aluminum panels shall be of die-cast or extruded construction.

2.2.02 Hollow Formed Steel Panels. Steel panels shall be of die-formed construction, consisting of a flat steel top sheet welded to one or more formed steel stiffener sheets. Panels shall be chemically cleaned, bonderized, and painted with the manufacturer's standard finish.

2.2.03 Metal-Clad Cementitious Fill Panel (Composite Panels). Composite panels shall be of die-formed steel construction totally enclosing the panel, including the top surface. The void spaces between the top sheet and the formed steel bottom sheet shall be completely filled with an incombustible cementitious or concrete material.

2.2.04 Metal-Clad Wood Core Panels. Wood core panels shall have cores of wood particleboard conforming to ANSI A208.1, Grade 1-M-3, or of plywood conforming to DOC PS 1, EXT-DFPA-C-C. The core shall be not less than 1 inch (25 mm) thick, and shall be faced on both sides with structurally bonded zinc-coated steel sheets not lighter than 24 gauge (0.70 mm). All edges and corners shall be sealed with zinc-coated steel or extruded aluminum. The completed panels shall have a flame spread rating of 25 or less when tested in accordance with ASTM E 84.

2.2.05 Concrete Panels. Concrete panels shall be of lightweight structural concrete with either structural reinforcing or a die-formed, electro-galvanized steel bottom pan. All concrete surfaces including those resulting from field cuts shall be sealed with the manufacturer's standard sealer before covering the surfaces with other materials.

2.3 FLOOR COVERING. Floor panels shall be surfaced with materials firmly bonded in place with waterproof adhesive. The electrical resistance shall remain stable over the life expectancy of the floor covering. Any anti-static agent used in the manufacturing process shall be an integral part of the material, and shall not be surface applied. Bolt heads or similar attachments shall not rise above the traffic surface.

2.3.01 High Pressure Laminate. High pressure laminate surfacing shall conform to NEMA LD 3, Grade HW 62. Total system electrical resistivity from the wearing surface of the floor to the ground connection shall be between 150,000 ohms and 20,000,000,000 ohms.

Conductive high pressure laminate floor surfacing shall conform to FS SS-T-312, Type III, Vinyl Tile and UL 779. The total system electrical resistivity from the wearing surface of the floor to the ground connection shall be between 25,000 ohms and 1,000,000 ohms.

2.3.02 Vinyl Composition Tile. Vinyl composition tile surfacing shall be 1/8 inch (3 mm) thick conforming to FS SS-T-312, Type IV, Composition 1. Tiles may be approximately 12 inches (300 mm) square or may be the full size of the panel.

2.4 ACCESSORIES. Perforated panels shall be provided for use in areas with hard surfaces such as high pressure laminates, and grilles or registers shall be provided in areas with carpet.

Registers, grilles, perforated panels, and plenum dividers shall be provided where indicated, and shall be the manufacturer's standard type. Registers, grilles, and perforated panels shall be designed to support the same static loads as floor panels without structural failure, and shall be capable of delivering the air volumes indicated. Registers and perforated panels shall be 25 percent open area and shall be equipped with adjustable dampers.

2.4.01 Edge Strip. Panels shall be edged with extruded vinyl edge strips secured in place with mechanical interlock or adhesive bond, or shall be of a replaceable type. Top of strip shall be approximately 1/8 inch (3 mm) wide, and shall be flush with the floor surfacing.

2.4.02 Resilient Base. Base shall be manufacturers standard rubber coved style. Base shall be 4 inches (100 mm) high and a minimum 1/8 inch (3 mm) thick. Pre-formed outside corners shall be furnished.

2.4.03 Lifting Device. Each individual room shall be provided with one floor panel lifting device standard with the floor manufacturer. A minimum of two devices shall be furnished.

2.4.04 Fascia. Aluminum or steel fascia plates shall be provided at open ends of floor, at sides of ramps and steps, and elsewhere as required to enclose the free area under the raised floor. Steel plates shall have a factory applied baked enamel finish. Finish on aluminum plates shall be as standard with the floor system manufacturer. Fascia plates shall be reinforced on the back, and shall be supported using the manufacturer's standard lateral bracing at maximum 4 feet (1200 mm) on center. Trim, angles, and fasteners shall be provided as required.

2.4.05 Steps and Ramps. Steps and ramps shall be securely fastened to the raised floor system and to the structural floor. Construction shall include standard floor system components and custom components as required, and shall include all supports, fasteners, and trim necessary for a finished installation. Step nosings, threshold strips, and floor bevel strips shall be cast or extruded aluminum with non-slip traffic surfaces.

Height of step risers shall not exceed 7 inches (180 mm). Steps shall be designed to support a uniform load of 150 pounds per square foot (7.18 k Pa). Treads shall be surfaced with the manufacturer's standard non-slip floor finish.

Slope of ramps shall not exceed 1-inch (25 mm) rise to 12 inches (300 mm) of run. Ramps shall be designed to support the same loads as specified for floor panels. Ramps shall be surfaced with the manufacturer's standard non-slip floor finish.

2.4.06 Railings. Railings shall be the double rail and post type, fabricated of at least 1 inch (25 mm) round or square seamless aluminum tubing with a satin natural anodized finish. At steps and ramps, the top rail shall be approximately 36 inches (900 mm) high and parallel to the incline. The top rail shall be 42 inches (1050 mm) high at open ends of the floor.

2.5 PANEL SUPPORT SYSTEM.

2.5.01 Pedestals. Pedestals shall be of steel or aluminum or a combination thereof. Ferrous materials shall have a factory-applied corrosion-resistant finish. Pedestal base plates shall provide a minimum of 16 square inches (10,300 square millimeter) of bearing surface and shall be a minimum of 1/8 inch (3 mm) thick. Pedestal shafts shall be threaded to permit height adjustment within a range of approximately 2 inches (50 mm) to permit overall floor adjustment within plus or minus 0.10 inch (2.5 mm) of the required elevation, and to permit leveling of the finished floor surface within 0.062 inch (1.56 mm) in 10 feet (3000 mm) in all directions. Locking devices shall be provided to positively lock the final pedestal vertical adjustments in place. Pedestal caps shall interlock with panels to preclude tilting or rocking of the panels.

2.5.02 Stringers. Stringers shall be of rolled steel or extruded aluminum, and shall interlock with the pedestal heads to prevent lateral movement.

2.6 COLOR. Color shall be as provided in Color Schedule or as selected by Engineer from submittals.

PART 3 - EXECUTION

3.1 INSTALLATION. Raised flooring shall be installed at the location and elevation and in the arrangement shown on the drawings. The floor system shall be of the stringer type, complete with all supplemental items, and shall be the standard product of a manufacturer specializing in the manufacture of raised floor systems.

The floor system shall be installed in accordance with the manufacturer's instructions and with the approved detail drawings. Open ends of the floor, where the floor system does not abut wall or other construction, shall have positive anchorage and rigid support. Areas to receive raised flooring shall be maintained between 60 and 90 degrees F (16 and 32 degrees C) and between 20 percent and 70 percent humidity for 24 hours prior to and during installation.

3.1.01 Preparation for Installation. The area in which the floor system is to be installed shall be cleared of all debris. Structural floor surfaces shall be thoroughly cleaned and all dust shall be removed. Floor coatings required for dust or vapor control shall be installed prior to installation of pedestals only if the pedestal adhesive will not damage the coating. If the coating and adhesive are not compatible, the coating shall be applied after the pedestals have been installed and the adhesive has cured.

3.1.02 Pedestals. Pedestals shall be accurately spaced, and shall be set plumb and in true alignment. Base plates shall be in full and firm contact with the structural floor, and shall be secured to the structural floor with adhesive or steel expansion anchors.

3.1.03 Stringers. Stringers shall be interlocked with the pedestal caps to preclude lateral movement, and shall be spaced uniformly in parallel lines at the indicated elevation.

3.1.04 Auxiliary Framing. Auxiliary framing or pedestals shall be provided around columns and other permanent construction, at sides of ramps, at open ends of the floor, and beneath panels that are substantially cut to accommodate utility systems. Special framing for additional lateral support shall be as shown on the approved detail drawings.

3.1.05 Panels. The panels shall be interlocked with supports in a manner that will preclude lateral movement. Perimeter panels, cutout panels, and panels adjoining columns, stairs, and ramps shall be fastened to the supporting components to form a rigid boundary for the interior panels. Floors shall be level within 1/16 inch measured with a 10 foot (2 mm measured with a 250 mm) straightedge in all directions. Cut edges of steel and wood-core panels shall be painted as recommended by the panel manufacturer. Cut edges of composite panels shall be coated with a silicone rubber sealant or with an adhesive recommended by the panel manufacturer. Extruded vinyl edging shall be secured in place at all cut edges of all panel cutouts to prevent abrasion of cables. Where the space below the floor is a plenum, cutouts for conduit and similar penetrations shall be closed using self-extinguishing sponge rubber.

3.1.06 Resilient Base. Base shall be provided at vertical wall intersections. Cracks and voids in walls and other vertical surfaces to receive base shall be filled with an approved filler. The base shall be applied after the floor system has been completely installed. Base shall be applied with adhesive in accordance with the manufacturer's recommendations.

3.1.07 Repair of Zinc Coating. Zinc coating that has been damaged, and cut edges of zinc-coated components and accessories, shall be repaired by the application of a galvanizing repair paint. Areas to be repaired shall be thoroughly cleaned prior to application of the paint.

3.1.08 Cleaning. The space below the completed floor shall be free of all debris. Before any traffic or other work on the completed raised floor is started, the completed floor shall be cleaned in accordance with the floor covering manufacturer's instructions.

3.1.09 Protection. Traffic areas of raised floor systems shall be protected with a covering of building paper, fiberboard, or other suitable material to prevent damage to the surface. Cutouts shall be covered with material of sufficient strength to support the loads to be encountered. Plywood or similar material shall be placed on the floor to serve as runways for installation of heavy equipment. Protection shall be maintained until the raised floor system is accepted.

3.2 FIRE SAFETY. An automatic detection system shall be installed below the raised floor meeting the requirements of NFPA 75 paragraph 5-2.1 and shall sound an audible and visual alarm. Air space below the raised floor shall be subdivided into areas not exceeding 10,000 square feet (929 squared meters) by tight, noncombustible bulkheads. All penetrations for piping and cables shall be sealed to maintain bulkhead properties.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Testing. Testing of electrical resistance in the completed installation shall be conducted in the presence of the Contracting Officer. Testing shall be in accordance with NFPA 99 modified by placing one electrode on the center of the panel surface and connecting the other electrode to the metal flooring support. Measurements shall be made at five or more locations. Each measurement shall be the average of five readings of 15 seconds duration at each location. During the tests, relative humidity shall be 45 to 55 percent and temperature shall be 69 to 75 degrees F (21 to 24 degrees C). The panels used in the testing will be selected at random and shall include two panels most distant from the ground connection. Electrical resistance shall be measured with instruments that are accurate within 2 percent and that have been calibrated within 60 days prior to the performance of the resistance tests. The metal-to-metal resistance from panel to supporting pedestal shall not exceed 10 ohms. The resistance between the wearing surface of the floor covering and the ground connection, as measured on the completed installation, shall be in accordance with paragraph FLOOR COVERING.

3.4 SPARE PARTS. Spare floor panels, spare complete pedestal assemblies, and spare stringers shall be furnished at the rate of one space for each 100 or fraction thereof required.

3.5 MAINTENANCE.

3.5.01 Operations and Maintenance Manuals. Provide maintenance instructions for proper care of the floor panel surface. When conductive flooring is specified, require submittal of maintenance instructions to identify special cleaning and maintenance requirements to maintain "conductivity" properties of the panel finish.

End of Section

SECTION 13700

POLYETHYLENE CHEMICAL STORAGE TANKS

PART 1 – GENERAL

1.1 SCOPE. This specification covers upright, cylindrical, flat and/or cone bottom polyethylene upright storage tanks molded in one-piece seamless construction by rotational molding. The tanks shall be designed for above-ground, vertical installation and shall be capable of containing chemicals at atmospheric pressure.

1.2 GENERAL.

1.2.01 General Equipment Stipulations. Provide tanks classified as Type I or Type II as indicated. Type I tanks are molded from cross-linkable polyethylene resin. Type II tanks are molded from linear polyethylene resin (not cross-linkable resin).

1.2.02 Governing Standards.

ASTM (American Society for Testing and Materials) D618 – Specification for Conditioning Plastics and Electrical Insulating Materials for Testing.

ASTM D638 – Specification for Tensile Properties of Plastics.

ASTM D790 – Specification for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulation Materials.

ASTM D883 – Specification for Definitions of Terms Relating to Plastics.

ASTM D1505 – Specification for Density of Plastics by the Density-Gradient Technique.

ASTM D1525 - Test Method for Vicat Softening Temperature of Plastics.

ASTM D1693 - Test Method for Environmental Stress-Cracking of Ethylene Plastics.

ASTM D1998 – Specification for Polyethylene Upright Storage Tanks.

ASTM D2765 – Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.

ASTM D2837 – Specification for Method for obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

ASTM D3892 – Specification for Practice for Packaging/Packing of Plastics.

ASTM F412 – Specification for Definitions of Terms Relating to Plastic Piping Systems.

ARM (Association of Rotational Molders) Low Temperature Impact Resistance (Falling Dart Test Procedure).

ANSI (American National Standards Institute) B-16.5 - Pipe Flanges and Flanged Fittings.

29 CFR 1910.106 Occupational Safety and Health Administration Flammable and Combustible Liquids.

BOCA (Building Officials and Code Administrators) National Building Code (Latest Edition).

Chemical Resistance Guide for Elastomers, Compass Publications, Kenneth M Pruett.

Compass Corrosion Guide II, Compass Publications, Kenneth M Pruett.

1.3 QUALITY ASSURANCE.

These references shall be considered as general guidelines only.

1.3.01 Manufacturer's Qualifications. Tank manufacturer shall have a minimum of 5 years experience manufacturing storage tanks of the type specified.

1.3.02 Contractor's Qualifications. Contractor shall have a minimum of 5 years experience installing tanks of the type specified and be certified by the manufacturer.

1.3.03 Chemical Compatibility. Chemical compatibility shall be according to the following chemical resistance guides:

Pruett, Kenneth M., "Chemical Resistance Guide for Elastomers", Compass Publications.

Pruett, Kenneth M., "Compass Corrosion Guide II", Compass Publications

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit detailed shop drawings showing details of construction and erection and product data for tanks, fittings, and accessories.

1.4.02 Certifications. Submit certification from manufacturer for tanks being provided that they are chemically compatible with materials to be stored for the design of the tank.

1.4.03 Samples. Submit a representative sample of the proposed tank wall.

1.5 DELIVERY, STORAGE, AND HANDLING.

1.5.01 Markings. The tanks shall be marked to identify the product, date of manufacture (month and year), capacity, and serial number. The tanks shall be shipped with a 3 of 9, HRI bar code label containing tank description, manufacturing order number, part number, serial number, manufacturer, and date.

Provide the proper caution or warning signs as prescribed by OSHA standard 29 CFR 1910.106.

1.5.02 Packing. All packing, packaging, and marking provisions of ASTM Practice D3892 shall apply to this standard.

Tank shall be shrink wrapped and bagged for shipping. All fittings shall be shipped separately.

1.5.03 Shipping. The manufacturer's instructions shall be followed in cases for shipping and unloading of tanks. Tanks with capacities of 2000 gallons (7,570 L) or more shall have molded-in lifting lugs provided to assist with tank handling.

Upon arrival at the site, the Engineer shall be responsible for inspection for damage in transit. If damage has occurred, the contractor shall repair or replace the tank as determined by the Engineer.

1.6 WARRANTY. Manufacturer shall fully warrant tank, fittings, and accessories for a minimum of 3 years from date of acceptance.

PART 2- PRODUCTS

2.1 SERVICE CONDITIONS. Tanks classified as Type I are not intended for materials above 140 degrees F (60 degrees C). Type II tanks are not intended for materials above 130 degrees F (54.4 degrees C).

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. The minimum required wall thickness for the cylinder straight shell shall be sufficient to support its own weight in an upright position without any external support. Flat areas shall be provided to allow locating large fittings on the cylinder straight shell.

The top head shall be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2000 or more gallons (7,570 L) of capacity shall be designed to provide a minimum of 1300 square inches (.83 sq m) of flat area for fitting locations.

Where indicated on the Drawings, the tank head shall be designed to support a mixer. Inspection manholes shall be provided on tank heads as indicated on the Drawings.

Tanks with 2000 or more gallons (7,570 L) of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.

The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading situations for Southeast Michigan without tank damage. Contractor shall coordinate with Engineer so all tanks have a high level alarm to prevent overflowing.

2.3 MATERIALS. The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. All polyethylene resin material shall contain a minimum of a U.V. 8 stabilizer as compounded by the resin manufacturer. Pigments shall not exceed 0.25 percent (dry blended) of the total weight.

2.3.01 Type 1 Tanks. Type I tanks shall be made from crosslinkable polyethylene resin as manufactured by Phillips 66, or resin of equal physical and chemical properties. Mechanical Properties of Type I Tank Material shall be as follows:

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.938-0.944 g per cc (35 lb per in cu)
Tensile (yield Stress 2 in per min)	D638	2600 PSI (17,924 kPa)
Elongation at Break (2 in per min)	D638	400 percent
ESCR (100 percent lgepal, Cond. A, F50)	D1693	>1000 hours
ESCR (10 percent lgepal, Cond. A, F50)	D1525	>1000 hours
Vicat Softening Degrees F. Temperature	D1525	248 (120 degrees C)
Flexural Modulus	D790	100,000 PSI (689,400 kPa)

2.3.02 Type II Tanks. Type II tanks shall be made from linear polyethylene resin as manufactured by Exxon Chemical, or resin of equal physical and chemical properties. Mechanical Properties of Type II Tank Material shall be as follows:

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.940-0.947 g per cc (35 lb per in cu)
Tensile (Yield Stress 2 inch per min)	D638	2700 PSI (18,614 kPa)
Elongation at Break (2 inch per min)	D638	350 percent
ESCR (100 percent lgepal, Cond A, F50)	D1693	400-1000 hours
ESCR (10 percent lgepal, Cond. A, F50)	D1693	200-500 hours
Vicat Softening Degrees F. Temperature	D1525	235 (113 degrees C)
Flexural Modulus	D790	97,000 - 103,000 PSI (668,718 – 710,082 kPa)

2.3.03 Fittings - General. All tank fitting attachments shall be equipped with flexible couplers or other movement provision. The tank will deflect based upon tank loading, chemical temperature, and storage time duration. Tank piping flexible couplers shall be designed to allow 4 percent design movement. Movement shall be considered to occur both outward in tank radius and downward fitting elevation from the neutral tank fitting placement.

2.3.04 Threaded Bulkhead Fittings (Nozzles). Provide threaded bulkhead fittings for below liquid installation for fittings up to 2 inches (5.1 cm) in diameter. Fittings shall be placed away from tank knuckle radius and flange lines.

The fittings shall be sized in accordance with the following table.

Fitting Size	Maximum Wall Thickness
<3/4 inch (< 1.9 cm)	0.750 inch (1.9 cm)
3/4 inch (1.9 cm)	0.875 inch (2.2 cm)
1 inch (2.5 cm)	0.875 inch (2.2 cm)
1 1/4 inch (3.2 cm)	0.875 inch (2.2 cm)
1 1/2 inch (3.8 cm)	0.875 inch (2.2 cm)
2 inch (5.1 cm)	1 inch (2.5 cm)
3 inch (7.6 cm)	1.125 inch (Flat Surface Only) (2.9 cm)

Bulkhead fittings shall be constructed of PVC, PP, or other specified material.

Gaskets shall be a minimum of 1/4 inch (6.4 mm) thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton®, Baggby type gaskets, or other specified material.

2.3.05 Bolted Double 150 lb. Flange Fittings. Provide bolted double flange fittings for below liquid level installation for sizes above 2 inches (5.1 cm). Fittings shall be placed away from tank knuckle radius and flange lines. Size the fittings in accordance with the table shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 inch - 86 inch (122 – 218 cm)	3 inch (6.8 cm)
90 inch - 102 inch (202 – 230 cm)	6 inch (13.5 cm)
120 inch - 142 inch (270 – 320 cm)	8 inch (18.0 cm)

Bolted double flange fittings shall allow tank wall thickness up to 2 1/2 inch (6.4 cm).

Bolted double flange fitting shall be constructed with 2 -150 lb. (68 kg) flanges, 2-150 lb. (68 kg) flange gaskets, and the correct number and size of all-thread bolts for the flange specified by the flange manufacturer. The flanges shall be constructed of PVC Type I, Grade I or other specified material. Gaskets shall be a minimum of 1/4 inch (6.4 mm) thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton® or other specified material. There shall be a minimum of 4 full thread bolts. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. The encapsulated bolt shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4 inch (6.4 mm) of the threads closest to the bolt head. The polyethylene shall be color coded to distinguish bolt material (white - 316 S.S., yellow - Hastelloy C276, red - Monel, green - Titanium). Each encapsulated bolt shall have a gasket to provide a sealing surface against the inner flange.

Standard orientation of bolted double flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B-16.5 unless otherwise specified.

2.3.06 Bolted Stainless Steel Fittings. Provide bolted stainless steel fittings where indicated on the Drawings. Fittings shall be placed away from tank knuckle radius and flange lines. Size the fittings in accordance with the table shown below.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 inch (108 cm)	3 inch (6.8 cm)
64 inch - 142 inch (144 – 320 cm)	4 inch (9.0 cm)

Bolted stainless steel fittings shall allow tank wall thickness up to 2 1/2 inch (6.4 cm)

Bolted stainless steel fittings shall be constructed with a minimum of 4 fully threaded 3/8 inch (9.5 mm) studs. Each fitting shall have two gaskets and two flanges. One gasket shall be compressed between the inside of the tank wall surface and the inside flange of the fitting. The other gasket shall be compressed between the outside tank wall surface and the outside flange of the fitting. Provide stainless steel fittings with male or female pipe threads as indicated the Drawings or as specified. The fittings shall be constructed of Type 316 stainless steel. Gaskets shall be a minimum of 1/4 inch (6.4 mm) thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton® or other specified material.

2.3.07 Siphon Tube Fittings. Provide Siphon tubes with the above specified fittings Siphon tubes allow fittings, when used as drainage fittings to provide better tank drainage.

2.3.08 Self-Aligning Threaded Bulkhead Fittings. Furnish self-aligning fittings where indicted on the Drawings or as specified for installation in vapor phase applications on curved surfaces. Fittings shall be placed away from tank radius. The maximum allowable size for self-aligning fittings placed on a spherical section of the tank is shown below.

Tank Diameter	Maximum Fitting Size Allowable
45 inch - 48 inch (114 – 121 cm)	2 inch (5.1 cm)
64 inch - 142 inch (162 – 361 cm)	3 inch (7.6 cm)

The maximum thickness and installation angle for fitting sizes are shown below.

Fitting Size	Maximum Angle	Maximum Thickness
1 inch (2.5 cm)	27 degrees	1.000 inch
2 inch (5.1 cm)	25 degrees	0.750 inch

3 inch (7.6 cm)	20 degrees	1.000 inch

Self-aligning fittings shall be constructed of PVC or other specified material. Gaskets shall be a minimum of 1/4 inch (6.4 mm) thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton®, or other specified material.

2.3.09 Snyder Unitized Molded Outlet (SUMO) Fittings. Provide SUMO fittings as an integral part of specified tanks. SUMO fittings will facilitate complete drainage of the stored liquid through the sidewall of a flat bottom container without the use of a special support structure or concrete pad.

The tank attachment shall be constructed from a PVC schedule 80 male adapter or other material in the size indicated. The fitting orifice shall not be less than schedule 80 interior pipe size per ANSI B36.10. O-rings shall be constructed of 70 +/- 5 durometer Viton® or other specified material.

2.3.10 Sight Level Gage. The sight level gage shall be constructed of flexible PE tubing to allow for tank contraction and expansion due to loading and temperature changes. The level gage shall be connected to the tank with 2 appropriate 3/4 inch (1.9 cm) fittings as described in the proceeding paragraphs. Provide valves installed for isolation or drainage purposes where indicated or specified.

2.3.11 Float Level Gage. The float level gage shall be constructed of a guided float on the inside of the tank connected to a weight indicator on the exterior of the tank with a 1/4 inch (6.4 cm) rope. The weighted indicator shall move along inside a clear guide pipe and shall be equipped with a volumetric indicator board. The indicator board shall be PVC material and may be attached to the clear guide pipe. The board shall be stenciled with one hundred gallon (liters) marks and labeled every five hundred gallons (liters). The level gage shall be connected to the tank at an appropriate tank flat on the tank dome with a 3 inch (7.6 cm) threaded bulkhead fitting and held along the tank sidewall with appropriate 1 inch (2.6 cm) fittings and stand-off connections.

The float level gage rigid components shall be constructed of PVC or other specified material. The rope shall be constructed of polypropylene or other specified material. Gaskets shall be constructed of EPDM, Viton® or other specified material.

2.3.12 Ultrasonic Level Indicator. The ultrasonic level indicator when specified, shall consist of a 2 or 3 inch (5.1 – 7.6 cm), 4 - 20 mA output PVC sensor and a 3 1/2 inch (8.9 cm) digital display unit. The sensor may be equipped with male pipe threads and be connected to the tank head with a PE bulkhead fitting, or the sensor may be Teflon® faced and flanged bolted to the tank head with encapsulated 316 S.S. bolts. The sensor shall be connected to a display unit mounted on the containment tank. The display unit box shall be Nema 4X rated and factory prewired for 110 VAC power. All connections shall be labeled to prevent errors in field installation. The display unit shall be preprogrammed for the particular tank. The display shall show hundreds of gallons (liters) (display x 100 = gallons (liters)).

2.3.13 Manway and Fill Cap (Non-sealed). Tank shall have fill caps, 10 inch (25.4 cm) vented-threaded style with a minimum opening diameter of 7.125 inch (18.1 cm). Cap attachment shall be provided with all standard 10 inch (25.4 cm) cap placements with a polyurethane cap tie.

Include Manway 18 inch (45.7 cm) vented-threaded style (minimum opening diameter of 16 inch (40.6 cm)), or 24 inch (21.5 cm) vented threaded style (minimum opening diameter of 22 inch (55.9 cm)) or 24 inch (21.5 cm) slip fit style (minimum opening diameter of 19.25 inch 48.9 cm)).

All caps and manways shall be constructed of polyethylene material.

2.3.14 Bolted Sealed Top Manway. Provide sealed manways, in 18, 20 or 24 inch (45.7, 50.8 or 61.0 cm) sizes in selected positions as indicated on the Drawings or as specified.

The sealed manway shall be constructed of polyethylene material. The bolts shall be Isoplast® or other specified material. The gaskets shall be closed cell crosslinked polyethylene foam and Viton® materials.

2.3.15 Down Pipes and Fill Pipes. Down pipes and fill pipes shall be prepared per the approved drawings and specifications. All down pipes and fill pipes shall be supported at 5 ft. (1.5 m) maximum intervals with support structures.

All down pipes and fill pipes shall be constructed of PVC or other specified materials.

2.3.16 U-Vents. Each tank shall be properly vented for the type of material and flow rates expected. Vents shall comply with OSHA 1910.106 (F) (iii) (2) (IV) (9) normal venting for atmospheric tanks or other accepted standard, or shall be as large as the filling or withdrawal connections, whichever is larger but in no case less than 1 inch (2.5 cm) nominal inside diameter.

All U-vents shall be constructed of PVC or other specified materials.

2.3.17 Flange Adapters. Where required, provide flange adapters to adapt threaded or socket fitting outlets to 150 lb. (68 kg) flange connections for connection to piping system components. Flange adapters shall be PVC, CPVC or other specified materials. Flange adapter construction shall utilize schedule 80 components in sizes required for particular tank configuration.

2.3.18 Tank Ladders. Ladders shall be constructed of painted mild steel, stainless steel, FRP or other specified material.

Safety cages shall be provided with ladders where indicated on the Drawing. All ladders shall be designed to meet applicable OSHA 2206, 1910.27, Fixed Ladders.

Ladders shall be mounted to the tank to allow for tank expansion and contraction due to temperature and loading changes. All top ladder mounts shall be connected to integrally molded in attachment lugs that allow for tank movement.

2.3.19 Tie Down Systems. Tie down system shall be designed to withstand 110 MPH (176 Km PH) wind loads. Anchor bolts shall be provided by the Contractor per the manufacturer's instructions and the base plates for the system.

The tie down system shall be painted mild steel, 304 stainless steel or other materials as indicated on the Drawings or as specified.

2.3.20 Tank Heating Systems. Furnish heating systems for use with polyethylene tanks designed to meet specific requirements, including tank material type, tank size, low ambient temperature, and recommended maintenance temperature.

All control components of the heating system shall be mounted in water tight, high impact plastic box(es) with a gasketed cover.

All heating system components shall be Nema 4X rated and factory pre-wired for 110 or 220 VAC. All connections shall be labeled to prevent errors in field installation.

Each control box shall carry a decal attached to the inside surface of the cover, on which an electrical wiring diagram is printed.

Each control box shall contain two temperature controls. One control shall regulate the maintenance temperature setting and the other control shall regulate the high temperature setting. The maintenance temperature setting shall be set at the desired maintenance temperature. The high temperature setting shall be adjusted to 10 degrees above the desired maintenance temperature to a maximum of 130 degrees F (54 degrees C). All control systems shall be designed with a power off failure mode.

The heating panels shall be designed to wrap around and lie flat against the surface of the tanks. The heating panels shall have a maximum heating density of .09 watts per square inch (0.222 watts per sq cm). All heating panels and sensor bulbs shall be attached to the tank with 2 inch (5.1 cm) wide duct tape. Under no circumstances shall cable type heaters be used with polyethylene tanks.

Insulation used shall be polyurethane foam with a density of 2.0 - 3.0 lb per cubic foot (30 – 45 kg per cu m) with an "R" value of 8.33 per inch (2.5 cm). The foam shall be applied with a nominal thickness of 2 inch (5.1 cm) to all external tank surfaces except the tank bottom shell.

Upon completion of application and curing of the insulation, two full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment. The latex mastic may be gray (standard) or white in color.

2.3.21 Equipment Platforms. Equipment platforms shall be mounted on tie down lugs integrally molded into the top head of the tank secured for its intended use. If the equipment platform is being used on a tank with saddle type tie down lugs and supporting a mixer, it is recommended the platform and tank be tied down with a tie down system as described in Paragraph 2.3.19.

Equipment platforms shall be offered in painted mild steel or as indicated on the Drawings or as specified.

Equipment platforms shall be designed to support a load of 150 PSF (1,034 kPa) in addition to equipment and piping loads.

2.3.22 Cone Bottom Tank Stands. Where indicated, provide Cone Bottom Tank Stands in 30 or 45 degree cone styles with rated gross weight capacities for all manufacturer cone bottom tanks. The stands shall be designed for a minimum of 2.4 safety factor accounting for wind and seismic loads. Ratings are based on stands anchored to an appropriate concrete support structure and the tank adequately secured. Cone bottom tank stands shall be offered in painted mild steel or as indicated on the Drawings or as specified.

2.4 MANUFACTURE AND FABRICATION. The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel. Fine bubbles are acceptable with Type II tanks to the degree in which they do not interfere with proper fusion of the resin melt.

All cut edges where openings are cut into the tanks shall be trimmed smooth.

2.4.01 Tolerances. Dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.

The tolerance for fitting placements shall be +/- 0.5 inch (1.3 cm) in elevation and 2 degrees radial at ambient temperature.

2.5 SHOP TESTING. Test specimens shall be taken from fitting location areas or piggy-back test methods.

2.5.01 Low Temperature Impact Test. The test specimens shall be impacted in accordance with the standard testing methods as found in ASTM D1998.

2.5.02 Degree of Crosslinking Test (Percent Gel - Type I Only). The test method used shall be the ortho-xlene insoluble fraction (gel test) per ASTM D2765 Method C. This test method is for determination of the ortho-xlene insoluble fraction (gel) of crosslinked polyethylene.

The percent gel level for Type I tanks on the inside 1/8 inch (0.3 cm) of the wall shall be a minimum of 65 percent.

2.5.03 Ultrasonic Tank Thickness Test. All tanks 2000 gallons (7,400 L) or larger shall be measured for tank wall thickness at 6 inch (15.2 cm), 1 foot (30.5 cm), 2 feet (61.0 cm), etc. on the tank sidewall height at 0 degrees, 90 degrees, 180 degrees, and 270 degrees around the tank circumference with 0 degrees being the tank manway and going counter-clockwise per ANSI standard drafting specifications. A copy of this test report can be ordered when placing the original tank order. All tanks shall meet design thickness requirements and tolerances.

Furnish a copy of the test report for tanks smaller than 2000 gallons (7,400 L) when requested by the Engineer.

2.5.04 Hydrostatic Water Test. The hydrostatic water test shall consist of filling the tank to brim full capacity for a minimum of four hours and conducting a visual inspection for leaks. Perform a hydrostatic water test when requested by the Engineer.

PART 3 – EXECUTION

3.1 INSPECTION. The contractor shall inspect the site to receive the tank and ensure that the foundation is correctly installed and ready to receive the tank. The elevation of the tank base shall be checked to ensure it is as specified.

3.2 INSTALLATION. The contractor shall install the tank, fittings and accessories according to the Drawings and manufacturer's instructions.

All fitting connections shall be installed with flexible type connections as per the Manufacturers recommendations.

Make all pipe connections to tanks as shown on the Drawings.

Following the field test, tanks and support members shall be anchored in their final position according to the manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL. After installation, each tank connecting pipe, and associated valving shall be field tested by filling with water. The tank and fittings shall hold water without loss, evidence of weeping or capillary action for a period of 24 hours prior to acceptance. The Engineer may also inspect each tank for defects, damage, and conformance with the Specifications.

After testing, the tanks shall be thoroughly cleaned and dried.

Should any defects become evident during inspection, testing, or within the guarantee period, the Contractor shall repair or replace the defective tank or fitting as approved by the Engineer.

End of Section

SECTION 13750

STEEL CHEMICAL STORAGE TANKS

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installation of lined or unlined steel single or dual wall tanks for the storage of chemicals. Connecting piping, valves, and accessories not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 Coordination. All equipment for this section shall be furnished by a single supplier who shall be responsible for the design, coordination, and function of the assembly. The coordinating supplier shall verify that each component is compatible with all other components of the assembly; that all pipe sizes and materials are appropriate; and that all devices necessary for a properly functioning assembly have been provided.

1.2.02 General Equipment Stipulations. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the Contractor.

The equipment shall be furnished and installed complete with all components indicated on the drawings or specified, and any additional materials or construction required by the manufacturer's design.

1.2.03 Governing Standards. Unless otherwise specified, the work for this section shall conform to the applicable portions of the following:

> ASME (American Society of Mechanical Engineers).
>
> ASTM (American Society of Testing and Materials) A283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars.
>
> ASTM A1011 - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
>
> AWS D1.1 (American Welding Society) – Structural Welding Code – Steel.

AWS D1.3 – Structural Welding Code – Sheet Steel.

National Fire Protection Association.

UL (Underwriters Laboratories) Standard 142 – Steel Aboveground Tanks for Flammable and Cumbustible Liquids.

UL Standard 2085 - Insulated Aboveground Tanks for Flammable and Combustible Liquids.

Steel Tank Institute F-921 (STI) - Standard for Aboveground Tanks with Integral Secondary Containment.

Chemical Resistance Guide for Elastomers, Compass Publications, Kenneth M Pruett.

Compass Corrosion Guide II, Compass Publications, Kenneth M Pruett.

1.3 QUALITY ASSURANCE.

1.3.01 Welding Qualifications. Welding procedures, welders, and welding operators shall also be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, and/or in accordance with AWS D1.1 and AWS D1.3.

1.3.02 Manufacturer's Qualifications. Manufacturer shall have a minimum of 5 years experience successfully manufacturing steel chemical storage tanks of type specified here.

1.3.03 Testing. Each tank shall be tested in conformance with ASME Section VIII requirements and Manufacturer Data Report (Form U-1) shall be completed prior to shipment.

1.3.04 Chemical Compatibility. Chemical compatibility shall be evaluated according to the following chemical resistance guides:

Pruett, Kenneth M., "Chemical Resistance Guide for Elastomers", Compass Publications.

Pruett, Kenneth M., "Compass Corrosion Guide II", Compass Publications

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Submit complete fabrication, assembly, and installation drawings, together with detailed specifications and product data covering materials used, parts, devices, and other accessories forming a part of the equipment furnished.

1.4.02 Certifications. The manufacturer shall certify they have evaluated the product(s) to be stored and that the tank materials and structure to be provided will be compatible with the product(s) to be stored over the design life of the tank.

Submit operation and maintenance manuals for the tanks, equipment, and accessories furnished.

1.5 DELIVERY, STORAGE, AND HANDLING. The tank and component parts shall be adequately protected during all transportation, loading and unloading, storage, installation, and subsequent construction activities. All nozzles shall be properly protected at all times and shall be plugged to prevent contamination of the tank interior. Repairs of minor damage, including scratches and abrasions, may be made where permitted by the Engineer in the manner recommended by the manufacturer. If a tank is damaged beyond reasonable repair, in the opinion of the Engineer, it will be rejected and shall be replaced by the Supplier with an undamaged unit.

At no time shall a tank be dropped or rolled. All lifting shall be done using the lifting lugs or suitable slings.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The storage tank shall be double wall type with insulation between the two steel walls. The tank shall be aboveground, atmospheric type with suitable supports and accessories as indicated on the Drawings and specified herein. The tank shall be secured to a concrete base by anchor bolts (cast in reinforced concrete) through the tank support. The entire tank system shall be electrically grounded.

Tank installation shall be coordinated with other construction under this contract.

2.2 PERFORMANCE AND BASIS OF DESIGN REQUIREMENTS. Each tank shall be designed in accordance with the latest edition of Section VIII, Division 1, PART UW of the ASME Boiler and Pressure Vessel Code. An ASME Code Stamp is not required.

Tanks and supports shall be designed to meet the seismic loading of the City of Detroit.

Each tank shall have a bottom capable of being supported on a concrete base. Each tank shall be provided with a suitable overflow alarm and fitting.

Each tank shall be vented and will normally be used to store the specified chemical at atmospheric pressure. Although the tank shall be designed to withstand the hydrostatic head which would result with the tank and fill pipe surcharged with the stored chemical to 6 inches (15.2 cm) above the top of the tank.

Each tank shall be suitable to withstand internal corrosion from the material stored at a maximum temperature of 150 degree F (65.6 degrees C).

Thermal insulation shall be placed between the two steel walls of dual wall tanks at the factory and shall provide a minimum 2 hour fire rating.

The secondary outer steel tank of dual wall tanks shall be suitable to withstand external corrosion due to atmospheric conditions.

Tank heads shall be self-supporting structurally reinforced to withstand a super-imposed load of 250 pounds (550 Kg) at any point and shall be additionally reinforced as necessary for the required accessories. Any necessary supporting members shall be located on top of the head plate.

Tank nozzles and personnel manholes shall be provided as indicated and as specified herein. Each tank and associated appurtenances shall be fabricated from a minimum number of pieces, and vertical shell seams shall be staggered. Welding seams shall be located to clear all nozzle openings. All flange faces shall be true to the center line of the nozzles, and bolt holes shall straddle center lines unless noted elsewhere.

All welding shall be done by the electric arc process. All welding shall be full and continuous, of uniform size and free from slag, porosity, undercuts, and other defects. All welds shall be fully penetrated. The manhole flange shall be machined smooth for a gasket surface after welding.

Provisions shall be made for anchoring each completed tank to the concrete base. Tanks shall be provided with anchor bolts and hold down lugs.

2.3 ACCEPTABLE MANUFACTURERS. Storage tanks shall be manufactured by a member in good standing of the Steel Tank Institute. Insulated tank manufacturers shall be licensed to build Fireguard type tanks.

2.4 MATERIALS.

Unless otherwise specified herein, material shall be suitable for continuous heavy duty industrial use and to withstand the service and environmental conditions specified. Materials shall be as follows:

Shell and plate (internal and outer)	ASTM A285, Grade C or ASTM A516, Grade 70: flange quality steel
Insulation	Lightweight thermal insulation suitable for preventing the internal tank temperature from rising 260 degrees F (126 degrees C) during a 2,000 degrees F (1093 degrees C) fire test for 2 hours
Nozzle and piping	ASTM A53, Grade B, Seamless
Flanges	ASTM A285, Grade C, flange quality
Structural shapes	ASTM A36
Bolts and nuts	Commercial quality carbon steel square head bolts and heavy cold press hex nuts
Gaskets	1/16 inch (1.6 mm) thick "Halon" TFE
Anchor Bolts	ASME approved, of same composition as base metal
Epoxy enamel	Ameron "Amercoat 385 Epoxy", Carboline "890" or Tnemec "Series 69 Hi-Build Epoxoline II"
Rubber Lining	0.2 inches (5 mm) vulcanized rubber or polyisoprene extending through and on the flanged faces of all tank connections, and continuous over all permanently attached brackets and supports

2.5 CONSTRUCTION. Dual wall internal and outer tanks shall both be of welded construction throughout and each shall be UL 142 listed and labeled. Other tanks shall be all welded construction with a minimum shell thickness of 3/8 inch (9.5 mm). All tanks shall include a 1/4 inch (6.4 mm) corrosion allowance in the wall thickness design.

Upon completion of dual wall construction, the exterior of the outer tank and inner tank interior seams shall be ground free of rough areas such that finished welds are full and rounded.

2.5.01 Surface Preparation. After fabrication, all metal surfaces and connections shall be blasted clean in conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.5.02 Painting. All exterior surfaces of each internal tank and the secondary outer tank shall be shop primed and painted in accordance with the tank manufacturer's requirements.

2.5.03 Connections. Connections on each tank shall be as indicated on the Drawings and as specified herein. All connections on the tank that are not used shall be capped.

All connections of dual wall tanks shall be sealed to prevent moisture from penetrating the outside of the secondary outer steel tank and shall maintain the specified fire rating.

2.5.04 Manway. The manway for each tank shall be an all welded extension cylinder in the location indicated on the drawings. The cover plate shall be the standard carbon steel manway cover furnished with the tank.

2.6 PROTECTIVE COATINGS. The exterior surfaces of each tank shall be thoroughly shop cleaned of all foreign materials as recommended by the paint manufacturer and shop painted with 7 mil (1.8 mm) thickness of epoxy enamel paint.

2.7 ACCESSORIES. Accessories shall be provided on each tank as indicated on the Drawings and as specified herein.

Each fill connection shall be suitably identified to indicate the type of product to be put into the tank.

A suitable means of sealing around the sensor wire entering the leak detection riser pipe shall be provided to prevent the annular space of dual wall tanks from being contaminated. Suitable fittings shall also be provided for a level transmitter to connect to the tank connection.

2.7.01 Vents. Each tank shall be provided with a flanged vent nozzle.

A check and vent valve assembly shall be mounted on the tank vent flange of tanks that draw air into the tank of tanks that to prevent corrosive fumes from entering the tank vent dryer. The valve shall be in accordance with Lectrodryer Drawing P-1050, as manufactured by Lectrodryer Division of Ajax Magnethormic Corp. with 2 1/2 inch (6.4) inlet and tank flange fittings. The vent valve exhaust port shall include a weather cover.

One tank vent breather shall be furnished and installed adjacent to the tank to remove moisture from the air drawn into the tank. The breather shall be Lectrodryer Division of Ajax Magnethormic Corp., "Model BR-50 Lectrobreather". A reactivator assembly shall be furnished and installed with the tank vent breather for periodic drying of the breather desiccant. The assembly shall be housed in a NEMA-4 enclosure, and shall include a 1/3 horse power motor and 2 kW heater for operation from a 120 volt, single phase, 60 Hz power supply.

2.7.02 Vent Covers. A 2 inch (5.1 cm) vent cover shall be provided on each tank vent in the location indicated on the Drawings. The cover shall have an aluminum body, 40 mesh screen over the outlet, and shall prevent rain from entering the vent line.

2.7.03 Dual Wall Internal Tank Emergency Vents. An emergency vent shall be provided on the top of each tank as indicated on the Drawings. The emergency vent shall relieve internal pressure in excess of 16 oz per square inch (73.37 ml per cm sq.)

2.7.04 Dual Wall Outer Tank Emergency Vents. A suitable secondary outer tank emergency vent shall be provided on top of the tank for the space between the two steel walls as indicated on the Drawings. The emergency vent shall relieve internal pressure in excess of 16 oz per square inch (73.37 ml per cm sq.) and shall be sized as required for proper operation.

2.7.05 Tank Supports. Tank support saddles or rails shall be provided with the tank at the spacing recommended by the manufacturer. Supports shall be fabricated of carbon steel as a part of the tank structure. Supports shall be of the size and design required to adequately support the tank and its contents, and shall be able to withstand the buoyancy forces when the tank is empty and covered with water.

2.7.06 Leak Detection Systems. Where indicated, tanks shall be provided with a leak detection system to continuously monitor the tank. The system shall consist of porous insulation, a riser pipe open on the bottom end and placed vertically next to and below the inner primary tank. Any leakage shall flow through the insulation to the riser pipe.

The system shall use a single sensor element to continuously monitor the presence of liquid in the riser pipe.

2.7.07 Access Manhole. The access manhole shall have an inside diameter of at least 24 inches (61.0 cm). One manhole shall be provided on the top of each storage tank and one shall be provided near the bottom on each tank. The tank manhole shall be flanged, fully gasketed, and furnished with a 5/8 inch (1.6 cm) minimum thick blind flange. Flange drilling and diameter shall conform to ANSI B16.5, 150 pound (330 Kg).

2.7.08 Flanged Nozzles. Nozzles for connecting piping shall be provided on each tank at the locations and of the sizes indicated on the Drawing or as specified herein. Each nozzle shall be flanged, with flange diameter and drilling conforming to ANSI B16.5, 150 pound (330 Kg). Flanged nozzles shall be fabricated of the same material as the tank.

Tank nozzles shall extend at least 4 inches (10.2 cm) from outside of face of tank to the face of the flange. Inlet or fill nozzles shall extend at least 4 inches (10.2 cm) into the tanks.

Two ultrasonic level sensor mounting nozzles are required. Level sensor nozzles shall be smooth bore, free and clear of frayed edges with 6 inch (15.2 cm) diameter raised outlet. Flanges shall be not be less than 18 inches (38.1 cm) above the maximum liquid level. Nozzle locations shall be on the top of the tank offset on either side of the tank center, equidistant from the centerline and wall. The centerline of the nozzles shall be at least 24 inches (61.0 cm) from the tank sidewall, fill nozzle, and other obstructions. Nozzles shall be located away from the fill stream or any other internal tank obstructions.

2.7.09 Tank Outlet. Each tank outlet assembly shall be as indicated on the Drawings. Outlets from sulfuric acid tanks shall be provided with a crank operated plug valve specifically designed for sulfuric acid service. The valve plug and seat shall be porcelain material. The valve seat shall be located in a welded tee fabrication at the tank outlet complete with a blind flange for washout. The valve crank operating mechanism shall be furnished through an 8 inch (20.3 cm) nozzle located on the top of the tank. General Chemical valve assembly "No. 50.78-6-A" is available from Kingsport Foundry and Manufacturing Corp., Kingsport, Tennessee or other as approved.

2.7.10 Gauge Glass. A chemical-resistant valve and gauge glass assembly shall be mounted on each storage tank. The gauge glass shall be fabricated of 1 inch (2.5 cm) clear schedule 40 PVC, and shall be graduated in 500 gallon graduations. Valve assemblies shall be PVC with integral ball checks to prevent flow in the event of gauge glass failure. The gauge shall be oriented so that the scale is visible from the normal personnel working area.

2.7.11 Certification Plates. A stainless steel certification plate shall be mounted on each storage tank. The following data shall be included on the certification plate:

Name of tank fabricator
Date of manufacture

Maximum allowable concentration and temperature of the specified chemical solution that can be stored safely
Mechanical properties of the tank

2.7.12 Ladder and Safety Cage. Each tank shall be provided with an exterior ladder and safety cage. A grating catwalk shall be provided at the top of the tank to the access manhole. The catwalk shall include safety rails attached to the ladder siderails, and anchored to the tank head as required. The ladder shall be supported on and anchored to the concrete base and bracketed to the tank shell as required. The ladder shall be fabricated of fiberglass reinforced plastic shapes, stainless steel, or carbon steel completely coated with at least 1/8 inch (.318 cm) of reinforced resin after fabrication. Uncoated or exposed carbon steel parts or fasteners will not be acceptable. The ladder shall have a clear width of at least 16 inches (40.6 cm), with rungs at least 3/4 inch (1.9 cm) in diameter and spaced not more than 12 inches (30.5 cm) apart. The clearance shall be at least 7 inches (17.8 cm) between the back of the ladder and the tank wall.

Safety handrails and kick plates meeting current OSHA requirements shall be provided around the top of each tank. Handrails shall be provided as required to surround the top manhole with adequate access space. The handrails and kick plates shall be designed and fabricated with the tank as a complete system.

PART 3 - EXECUTION

3.1 INSTALLATION. Each tank and components shall be adequately protected during transportation, in storage at the job site, and during subsequent installation and construction activities. Damaged units will be rejected and shall be replaced with undamaged units. The concrete bases shall be constructed in accordance with Master Specification Section 03300, Cast-in-Place Concrete and shall be level and smooth to the tolerances permitted by the tank manufacturer. The tank shall be installed in accordance with the manufacturer's recommendations, the supplier's written installation instructions, the applicable governing standard, to the satisfaction of the Engineer. The tank shall be made ready for the installation of piping and other appurtenances as indicated on the drawings and specified under the other sections. Grouting under the tank, if recommended by the tank fabricator, shall be done with non-shrink grout.

3.1.01 Field Painting. Field touch-up painting shall be performed as needed, using paint applied by the tank manufacturer and in accordance with manufacturer's instructions. Lettering as indicated on the Drawings shall be painted on the sides of the tank. Letters shall be of the block type, at least 5 inches (12.7 cm) high, spaced and proportioned to provide a well-balanced appearance. Two coats of paint shall be applied. Paint shall be supplied by tank manufacturer and compatible with shop-applied coating.

3.2 FIELD QUALITY CONTROL.

3.2.01 Field Testing. After shipment to the job site, but prior to installation, each inner primary tank and the secondary containment tank of dual wall tanks shall each be pressure tested separately at 5 psi (34.47 kPa) for 1 hour. The inner primary compartment tank and the secondary containment tank shall be checked for leaks, using an air gauge. During testing, connections may be plugged but shall not be blocked or plugged on the inside. If there are leaks or indications of leaks during either test, the tank shall be replaced with a new tank and tested after shipment to the job site.

End of Section

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DIVISION 14 – CONVEYING SYSTEMS

SECTION 14240

HYDRAULIC FREIGHT ELEVATOR

PART 1 - GENERAL

1.1 SCOPE. This section covers the design, fabrication, and installation of oil-hydraulic freight elevators as indicated in the Contract Documents.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

The elevator shall be furnished complete, including elevator car, car gate, hoistway doors, power unit, hydraulic jack and jack hole casing, microprocessor based electric controller, buffers, guides, guide attachments and anchors, oil and oil piping, electric wiring, required accessories, and all other accessories and appurtenances required for an operating installation.

The elevator shall be of the electric push-button microprocessor controlled, motor driven oil pump operated, hydraulic type using oil as the power transmitting medium, and shall be the latest standard product of a manufacturer regularly engaged in the production of hydraulic elevators. The elevator manufacturer shall be experienced in the design and construction of hydraulic elevators.

The elevator shall be provided complete with all equipment enclosures, pit ladders, and other items and accessories necessary to meet the requirements of the governing standards.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Contractor shall submit for review detailed drawings, catalog data, descriptive matter, and manufacturer's specifications, including complete motor data, for the proposed equipment. The drawings shall include the jack hole requirements, the locations of each guide bracket insert and the horizontal load at that point, and details of the required equipment base or bases. Such data shall be sufficiently detailed to enable Engineer to judge whether or not the proposed equipment conforms to each feature of the contract requirements, and shall be submitted as set forth in Master Specification Section 01080, Project Submittals.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damages of any kind. Damaged materials shall be promptly replaced. All materials shall be stored off the ground and protected from weather.

1.5 SPARE PARTS. Spare parts shall be provided as indicated in the Contract Documents. Spare parts shall be suitably packaged in accordance with the handling and storage requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1.5 WARRANTY. After the elevator installation and operation is acceptable to Engineer, the Elevator Manufacturer shall warrant all equipment for a period of four

(4) years. All other details of the warranty shall be in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 HYDRAULIC FREIGHT ELEVATOR. The freight elevator shall be of the model and performance as specified herein and shall be Thyssen Krupp, Montgomery Kone or Otis. Alternate suppliers may be proposed as required and as acceptable to Engineer.

2.2 PERFORMANCE AND DESIGN CRITERIA.

2.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and accessories furnished under this section.

2.2.02 Governing Standards. The elevator shall be designed, fabricated, and erected in accordance with ASME A17.1, the National Electrical Code, and all other applicable building and fire codes, laws, and regulations. In case of conflict, the applicable code, ordinance, law, or regulation shall govern.

2.2.03 Power Supply. Unless otherwise indicated, the power supply to the elevator power unit will be 480 volts, 3 phase, 60 Hz ac. The power supply for elevator ventilation, lighting, and miscellaneous circuits will be 120 volts, 60 Hz, single phase. A 3 pole, 600 volt, nonautomatic, externally operable, lockable, NEMA Type 1 surface-mounted circuit breaker shall be provided with the elevator for main disconnect and installed adjacent to the elevator controller. A 1 pole, 120 volt externally operable and lockable NEMA Type 1 surface mounted circuit breaker shall be provided with the elevator for 120 volt disconnect and installed adjacent to the elevator controller. The circuit breakers shall be sized per equipment supplied and in accordance with the NEC.

2.2.04 Metal Thicknesses. Metal thicknesses and gages specified herein are the minimum required. Gages refer to US Standard gage.

2.2.05 Protective Devices. All protective devices required by the governing standards, including stop switches, limiting and stopping devices, contacts, interlocks, and other safety devices, shall be provided whether or not specifically mentioned herein.

2.2.06 Modifications. Any additions or modifications to the structure as detailed or specified which may be required for proper installation or operation of the elevator furnished, or to meet the requirements of the governing standards, shall be done by and at the expense of Contractor.

2.2.07 Lifting Facilities. If lifting facilities are indicated, they may be used to facilitate lifting and handling equipment. The load imposed shall not exceed the specified load.

2.2.08 Maintenance. Contractor shall furnish maintenance and call-back service for the elevator equipment for a period of 1 year after the Work is accepted. The elevator shall be inspected and maintained in accordance with the current requirements of ASME A17-2.2, Inspector's Manual for Hydraulic Elevators. Maintenance service shall include monthly examinations by a competent representative of the manufacturer, all necessary adjustments, greasing, oiling, cleaning, supplies, and parts to keep the elevator equipment in operation, except those made necessary by misuse, accidents, or negligence by parties other than Contractor. Two spare fuses of each size and type used shall be provided for the power unit at the end of the maintenance period.

2.3 MATERIALS. Materials shall conform to the following:

Equipment Grout	Non-shrinking grout as specified in Master Specification Section 03600, Grout.
Jack Hole Casing Grout	Cementitious grout as specified in Master Specification Section 03600, Grout.
Touch-up Paint	As recommended or provided by the elevator supplier.
Finish Painting	As specified in Master Specification Section 09900, Painting.
Wiring, conduit, and other appurtenant material required for a complete electrical installation.	As specified in Master Specification Section 16050, Electrical General Requirements.

2.4 OPERATION. Operation shall be "Full-automatic push button", with the elevator controlled automatically by push buttons in the car marked to correspond with the respective levels and openings served, and by a single call button at each hoistway opening. The momentary pressure of any button shall operate the car. If the car gates and all hoistway doors are closed, the car shall travel to its destination in the direction chosen without interference. After the car has been placed in motion, all other push buttons shall become inoperative until the car has reached its designated landing.

Where power doors are specified, when the car has reached a landing in response to a landing call or a car signal, the car door and the hoistway door shall automatically open and shall remain open a set amount of time or until closed by the operation of a "Door Close" button as specified herein. A time delay adjustable for 0 to 60 seconds with manual override shall be provided to automatically close the car gate and hoistway doors after a set amount of time has elapsed after the doors are opened.

Where manually operated doors and gates are specified, a time delay noninterference feature shall be incorporated in each control circuit to allow ample time for manual opening of the car gate and hoistway door, once the car has reached a landing, before the car can be dispatched to another landing.

A two-way automatic maintaining leveling device shall cause reduced speed from either direction when approaching landing stops and automatically position at landings with an accuracy of 1/4 inch (6 mm), plus or minus, under all loading conditions. Landing level shall be maintained as long as the car is within the leveling zone.

Normal terminal stopping devices and emergency terminal speed limiting devices shall be provided in accordance with the governing standards.

2.5 HOISTWAY AND PIT. The hoistway construction is indicated on the drawings.

The elevator equipment shall be designed to accommodate the floor slope and the maximum depth at the walls of the elevator pit indicated on the drawings. The design of the pit walls and floor may be modified as needed to support the jack cylinder. The pit ladder may be relocated if necessary.

2.6 CAR PLATFORM AND ENCLOSURE. The car and platform frame shall be of welded steel construction, substantially braced and reinforced. The car enclosure shall not be subjected to excessive stresses caused by the elevator operation. The frame shall be provided with top and bottom guide shoes, and plates for connection of the jack.

2.6.01 Platform. The car platform shall be provided with double wood flooring. Bottom flooring shall be 1 inch (25 mm) thick, and top flooring shall be first-grade tongued and grooved hardwood, 1 inch (25 mm) nominal thickness. The underside of the platform shall be protected with a metal fire shield or fire-retardant paint in accordance with the governing standards.

2.6.02 Enclosure. The clear height of the car entrance and interior shall be at least equal to the hoistway entrance. The car shall be enclosed full height with 14 gage (1.90 mm) steel sheets suitably reinforced and securely fastened to the car frame and platform. Reinforced openings shall be provided where necessary for the operating panel and other accessories.

An engraved capacity and data plate, a loading designation sign, and a certificate frame, all fabricated of stainless steel, shall be mounted in the car near the operating panel in accordance with the governing standards.

2.6.03 Canopy. The canopy shall be 14 gage (1.90 mm) perforated or solid sheet steel or 10 gage (3.42 mm) expanded metal, suitably reinforced to conform to the governing standards. The canopy shall be rigidly fastened to the elevator car frame. Provisions shall be made for the vertically rising car gate.

2.6.04 Emergency Exit. An emergency exit shall be provided to conform with the governing standards.

2.6.05 Lighting. Lighting in the car shall be indirect or shielded fluorescent type, and shall be controlled by a switch on the car operating panel. Lighting shall be provided on the top of the car as specified by the governing standards.

2.7 CAR OPERATING PANEL. An operating panel fabricated of satin finish stainless steel shall be located at or near the front or rear of the car as specified, flush-mounted in the car wall. The operating panel shall include the following features:

A bank of buttons numbered to correspond to the landings and openings served. Buttons shall illuminate when pushed to register a call.

A switch for the car lights.

A switch for the car ventilating fan, when specified.

An emergency "Stop" button which will enable the operator to stop the car at any point in its travel.

An emergency "Alarm" button. The alarm button shall be of the continuous pressure type with two isolated contacts, one to operate a remote annunciator point at 120 volts ac and the other to operate an alarm bell. The bell shall be furnished and installed as part of the elevator equipment as specified herein. The remote annunciator will be furnished by others if it is required. Power to the bell will be from the 120 volt elevator service. Power for the annunciator point will be provided at the annunciator.

A key-operated switch to stop or start the unit.

If power doors are specified, a "Door Open" button to control the power operated car gate and hoistway doors. Momentary pressure on the button shall reverse the motion of closing doors, reopen the doors, and reset the interval.

If power doors are specified, a "Door Close" button to control the closing of the hoistway doors. This button shall be operable in conjunction with the delay interval sequence as specified.

The elevator shall be provided with a telephone and all necessary hardware. Telephone cable shall be provided by the elevator manufacturer from the telephone in the elevator to the telephone junction box located in the Elevator Equipment Room. All necessary hardware shall be provided and installed in the junction box to enable an external telephone circuit to be connected to the hardware provided by the elevator manufacturer to complete the telephone circuit.

2.8 CALL AND ALARM BELLS. An alarm bell shall be provided in the hoistway at the specified floor level, connected to the alarm button in the car operating panel.

A call bell shall be provided on the elevator car which shall ring when a landing button is pushed and the car gate or a hoistway door is open.

2. 9 TOP-OF-CAR OPERATING DEVICES. Provisions shall be made to operate the elevator from on top of the car during adjustment, inspection, maintenance, and repair, in accordance with the governing standards.

2.10 CAR GATE AND HOISTWAY DOORS. The following paragraphs apply to power and manual car gates and hoistway doors as specified.

2.10.01 Manual Operation. Where manual operated doors and gates are specified, the car gate and hoistway doors shall be manually operated, and shall be equipped with all necessary interlocks and safety devices. Manually operated doors and gate may only be opened when the elevator is at a landing.

2.10.02 Power Operation. Where power doors and gates are specified, the car gate and hoistway doors shall be electric motor operated, and shall be equipped with all necessary interlocks, controls and safety devices.

Gate and door movements shall be cushioned or checked at both limits of travel. The operating mechanism shall be arranged for manual operation in the event of a power failure. The electric operator shall be quiet and smooth in operation and designed for elevator service.

Doors shall preopen automatically as the car levels at the landing, and shall automatically close after a predetermined time or when the car is dispatched to another landing. The doors shall remain in the closed position with the elevator car at rest.

The bottom edge of the car gate shall be provided with safety edge designed to automatically return car gates and hoistway doors to the open position in the event doors are obstructed during closing cycle. If the obstruction continues, the alarm will sound.

2.10.03 Car Gate. A vertically rising, manually or power operated, counterbalanced steel mesh or expanded metal gate shall be furnished at the entrance to the car. The gate shall be equipped with electrical contacts to prevent operation of the elevator unless the gate is in the closed position. The gate may be either single or multiple section type, as needed by available overhead clearance when the car is at the uppermost landing.

A power operated gate shall be provided with a safety edge.

2.10.04 Hoistway Entrances and Doors. Hoistway entrances of the size and type indicated on the drawings shall be provided. All entrances shall be furnished complete with all doors, jambs, jamb extensions, heads, sills, hardware, and other accessories and appurtenances as required.

Hoistway entrances shall be equipped with manually or power operated, bi-parting, vertical sliding hoistway doors. Hoistway doors shall be fabricated from structural shapes, with 12 gage (2.66 mm) or thicker steel facing sheets on the lobby side. The doors shall be flush type without projecting bolts or rivets on the lobby side, and shall be of construction equivalent to UL Class B, 1-1/2 hour rating.

The doors shall operate inside the hoistway on continuous steel angle guide rails. Guide rails shall be rigidly anchored to the hoistway walls or structure and shall be carefully aligned to ensure proper operation of the doors. The leaves of each door shall be connected by noncorroding cables or chains running on sheaves with ball bearings, arranged so the upper leaf balances the lower leaf. The doors shall be designed to operate in the hoistway provided.

The upper edge of the lower leaf of each door shall be equipped with a truckable sill which will support loads equal to the capacity of the elevator. Each door shall be equipped with a device for holding the sill level independent of the suspension cables or chains when the door is fully open.

The lower edge of the upper leaf of each door shall be equipped with a flexible, non-crushing, non-shearing, fire-resistant safety meeting rail to provide a spacing of not less than 3/4 inch (19 mm) between the rigid members of the door sections when closed.

A 4 by 9 inch (100 by 225 mm) vision panel opening shall be provided in the upper leaf of each door. Vision panels shall be glazed with 1/4 inch (6 mm) diamond mesh wire glass.

The upper leaf of each door shall be equipped with a handle for emergency opening and a webbed strap or similar means for closing the door. A mechanical latch shall hold each door securely closed.

Each door shall be equipped with suitable electrical and mechanical interlocks which will prevent the operation of the elevator unless all doors are closed, and will prevent the opening of any door unless the car is at the corresponding landing.

The door at each landing shall be provided with a hoistway unlocking device in accordance with the governing standards. Two operating Master # 2246 keys shall be furnished.

If required by the drawings, the hoistway door at exterior openings shall be fully weatherstripped as recommended by the manufacturer and accepted by Engineer. Manually operated doors shall be fitted with the manufacturer's standard keyed locking device. The locking device shall have a manual release inside and shall be suitable for installation of the outside cylinder furnished under Master Specification Section 08710, Finish Hardware, master keyed to the building lock system. For power doors, the exterior push button station shall be provided with a keyed lockout device to disable exterior controls when locked.

2.11 <u>LANDING PUSH-BUTTON STATIONS</u>. A push-button station shall be provided at each hoistway opening. Each landing push-button station shall contain an "In-Use" light, a "Call" button, and door control buttons where power doors are specified. The "In-Use" light shall be illuminated while the car is in use, until the registered call has been completed. The "Call" button shall not function while the "In-Use" light is on. Push buttons shall be of the momentary pressure type and shall illuminate when pushed to register a call. Each landing push button shall be provided with a satin finish stainless steel cover plate. If required, the push-button station at each exterior door shall be waterproof.

2.12 CAR GUIDES. The car guides shall be heavy, planed steel guiderails erected plumb and secured to the building structure with heavy steel brackets attached to wall inserts or attached to the building structure as needed or detailed. All required inserts shall be furnished by the elevator supplier to be built into walls as indicated on the drawings. Guides shall be located at the sides of the hoistway. Ends of all guiderails shall be tongued and grooved, forming matched joints, and connected with steel splice plates.

Nylon or teflon inserts which require no lubrication shall be provided in car guides.

2.13 BUFFERS. Two heavy spring buffers shall be mounted in the pit. Buffers shall protect the jack packing gland should the car descend past the bottom limit switch. Buffer plates shall be provided on the underside of the car frame.

2.14 HYDRAULIC JACK. The hydraulic jack assembly shall comply with governing standards, and shall be rated for the specified service.

The cylinder shall be seamless steel tubing and shall have an end plug, cylinder head, hydraulic connection, and suitable mounting brackets. The cylinder head assembly shall have an adjustable packing gland and suitable packing, oil wiper, a bronze or babbitt guide bearing, air bleed, oil collector, and a shoulder to stop upward travel of the plunger. The plunger shall be heavy seamless steel tubing, machined and polished, shall have a stop ring or plate to limit upward travel, and shall have a heavy mounting plate for attachment to the car.

The jack assembly shall be shop tested at twice the operating pressure, without leakage or failure. Brittle material, such as gray cast iron or semisteel, shall not be used in jack construction.

2.14.01 Corrosion Protection. The jack cylinder shall be protected from corrosion by factory installation in a PVC casing with waterproof high pressure seal at the bottom. The PVC cylinder shall be sealed against any infiltration from flooding in the pit and shall be provided with a means of containing any leakage from the jack cylinder and shall provide means of detecting and removing any oil leakage or other contaminant from the interior of the PVC casing.

2.15 POWER UNIT. The power unit shall be compact, with all components listed below combined in a self-contained unit. The unit shall have a steel outer base with tank supports; an oiltight drip pan; an inner base for mounting the motor-pump assembly; an overhead oil reservoir with tight-fitting tank cover, oil fill strainer and oil level gauge assembly, and a self-cleaning strainer in the suction line; expanded metal sheave guard; an oil-hydraulic pump with electric motor and V-belt drive assembly; an oil control unit; and an electric controller. The oil reservoir capacity shall be at least 5 gallons (19 L) more than required to raise the elevator to full height.

The power unit assembly shall be mounted on vibration absorbing materials to isolate the unit from the building structure and shall be set on a concrete base at the location indicated on the drawings.

If the power unit is not specified to be located in a separate enclosed room, the power unit assembly shall be surrounded by an expanded metal or wire mesh enclosure which meets state and local codes and regulations. The enclosure shall be provided with a hinged door and suitable lock acceptable to Engineer.

2.15.01 Pump and Motor. The pump shall be especially designed and manufactured for oil-hydraulic elevator service and shall be rotary positive displacement type; gear or vane type pumps will not be acceptable. The output of the pump shall not vary more than 10 percent between no load and full load on the elevator car.

The motor shall be especially designed for oil-hydraulic elevator service, and shall be NEMA Type B with a 30 minute rating for elevator service. Motor rating shall equal or exceed the maximum load developed during operation of the elevator. The drive shall be multiple V-belts and sheaves of the number and size for the duty involved.

The pump shall be driven with multiple V-belts. Belts and sheaves shall be conservatively designed for the required service.

2.15.02 Oil Control Unit. The oil control unit shall consist of a high-pressure relief valve, a safety check valve, an automatic unloading up-start valve, an automatic unloading up-stop valve, a lowering valve, a leveling valve, a manual lowering valve, and a tank shutoff valve. All adjustments shall be accessible and shall be made without removing any item from the oil piping. Self-cleaning strainers shall be provided to prevent foreign materials from lodging in the control system.
The relief valve shall be externally adjustable, and shall be capable of bypassing the total oil flow without increasing back pressure more than 10 percent above that required to barely open the valve. The safety check valve shall be designed to close quietly without permitting any perceptible reverse flow and shall be designed to support the elevator on a positive locked column of oil when the car is at rest. The up-start valve shall be externally adjustable, and shall be designed to bypass oil flow during initial start of the motor-pump assembly and shall close slowly, gradually diverting oil to the jack unit, ensuring smooth up-starts, and to relieve load on the motor during starting. The up-stop valve shall be externally adjustable, and shall be designed to bypass the oil flow to ensure smooth up-stops and to compensate for inertia. The lowering valve and leveling valve shall be externally adjustable for drop-

away speed, lowering speed, leveling speed, and stopping speed to ensure smooth down-starts and stops. The manual lowering valve shall be designed for manual lowering of the elevator car in event of power failure and for use in servicing and adjusting the elevator mechanism. The tank shutoff valve shall be designed for isolating oil in the power unit tank to ensure ease of servicing and adjusting the elevator mechanism without removing the oil from the tank.

2.15.03. Electric Controller. The electric controller shall be microprocessor based with a magnetic type motor starter with silver-to-silver contacts on the contactors. Thermal overload relays shall be provided to protect each motor phase against overloading. A 120 volt control transformer with one secondary lead fused and the other grounded shall be provided in the controller for control circuit power and power for operation of interlocks. All switching shall be on the "hot" side of the 120 volt leads.

All components required for proper performance of the elevator shall be neatly mounted and wired on the front of a steel control panel, and completely enclosed in a cabinet with hinged doors, mechanically locked. The control cabinet shall be wall-mounted where indicated on the drawings. The electric control apparatus shall be completely isolated from the oil reservoir.

2.15.04 Piping. The power unit shall be complete with all piping necessary for the power unit and for connection to the jack unit. Piping shall comply with applicable piping sections. No rubber hose or mechanical flexible tubing shall be installed in the hydraulic piping system between the oil pump and the jack unit.

A blowout-proof hydraulic muffler device, designed to reduce hydraulic pulsations, shall be installed in the oil line near the power unit.

A mainline strainer and shutoff cock assembly, self-cleaning type with a 60 mesh element, and a magnetic drain plug shall be provided in the oil line. The unit shall be compact in design with easy access for cleaning.

All piping shall be tested at 1-1/2 times the maximum working pressure before being placed in service. All joints shall be made tight and all leaks shall be repaired and retested.

A sufficient quantity of oil shall be supplied in its original sealed container to fill the oil reservoir and piping as needed for proper operation.

2.16 LUBRICATION. Suitable provisions shall be made for lubrication of all equipment. The manufacturer shall furnish a chart with complete recommendations for equipment lubrication. An estimated 6 months' supply of each type and weight of lubricant required shall be provided in original sealed and labeled containers.

2.17 SMOKE DETECTORS. Smoke detectors shall be provided by the elevator manufacturer and mounted outside the elevator door at each landing and in the Elevator Room if one is provided. If power doors are provided, smoke detectors shall be wired into the elevator controls, and if smoke is detected, cause the elevator to go to ground level, open the door and remain in this condition until manually reset. Smoke detectors shall be powered from the electric controller and be provided with the necessary contacts to accomplish the specified sequence of operation.

2.18 PAINTING. All scale, rust, dirt and oil shall be removed from surfaces to be shop painted, by blast cleaning, pickling, or other acceptable methods.

All exposed surfaces of machinery, including motor, oil pump, tanks, and accessories therefore (except machined and noncorroding surfaces), shall be finished smooth, thoroughly cleaned, and shop primed. All exposed surfaces shall then be painted with two coats of first-quality machinery enamel.

Interior surfaces of the elevator car, all surfaces of the car gate, and all surfaces of the hoistway doors and frames shall be painted with one shop coat of universal primer. Exterior surfaces of the car frame and car enclosure, guiderails (except for rubbing contact surfaces), and other structural metal work within the hoistway shall be painted with two shop coats of universal primer.

Surfaces of the jack plunger shall not be painted, but shall be adequately protected from corrosion or other damage during shipment, storage, handling, and installation.

PART 3 - EXECUTION

3.1 ERECTION. Each hydraulic freight elevator and accessories shall be installed by an elevator erector and elevator mechanics who are acceptable to, and authorized for the work by, the manufacturer of the elevator furnished. Equipment will be erected in accordance with the manufacturer's instructions.

3.2 FINAL INSPECTION AND TESTING. At the conclusion of the elevator installation the Elevator Manufacturer's representative shall inspect and test the operation of all mechanisms, appliances, and operating devices. Tests shall comply with the governing standards. At the conclusion of the tests, the installation and operation shall be acceptable to Engineer.

End of Section

SECTION 14552

SCREW CONVEYORS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of shafted screw conveyors and shaftless screw conveyors for the locations as indicated in the Contract Documents.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated and assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

All structural and miscellaneous metal required shall conform to the requirements of Master Specification Section 05120, Structural Steel and Master Specification Section 05500, Metal Fabrications.

The supplier shall review the contract drawings and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow convenient collection of waste oil in containers from the operating area or platform without removing the unit from its normal installed position.
Grease fill openings shall be zerk fittings, buttonhead type, size as determined by Owner.

1.2.03 Abbreviations. Reference to standards and organization in this section shall be by the following designations:

AFBMA	Antifriction Bearing Manufacturers Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CEMA	Conveyor Equipment Manufacturers Association
MIOSHA	Michigan Occupational Safety and Health Administration

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, schematic and wiring diagrams, together with detailed specifications and data covering material used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications for each conveyor shall include, but shall not be limited to, the following:

Screw Conveyors and Accessories

Specifications for materials of construction.

Complete conveyor dimensions and weight.

Support details.

Support dead loads.

Rotating speed.

Detailed shop drawings of screw conveyors and trough body.

Maximum transport weight capacity.

Details of end and intermediate bearings.

Details of shaft seal system.

Slide Gates

Name of manufacturer and catalog data.

Detailed drawings and dimensions.

Specifications for materials of construction.

Actuator drawings and details.

Drive

Name of manufacturer.

Type and model.

Type of bearings and lubrication.

Input/output speed.

Net weight.

Service factor at installed horsepower.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as indicated in the Contract Documents. Spare parts shall be suitably packaged in accordance with the handling and storage requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1.6 WARRANTY. After the screw conveyor installation and operation is acceptable to Engineer, the Screw Conveyor Manufacturer shall warrant all equipment for a period of four (4) years. All other details of the warranty shall be in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Equipment provided under this section shall be suitable for the service conditions as indicated in the Contract Documents. Equipment shall conform to the applicable sections of the MIOSHA standards.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and products shall be as specified herein, or shall be equivalent products of manufacturers regularly producing screw conveyors, subject to acceptance by Engineer. All modifications necessary to accommodate the screw conveyors shall be subject to acceptance by Engineer and shall be made at no additional cost to Owner.

2.2.01 Screw Conveyors. The screw conveyors shall be as manufactured by American Bulk Conveyor, Continental Screw Conveyor, Thomas Screw Conveyor, U.S. Filter/Asdor, or approved equal.

2.2.02 Shaftless Screw Conveyors. The shaftless screw conveyors shall be manufacturered by American Bulk Conveyor, JDV Equipment Co., U.S. Filter/Asdor, or approved equal.

2.3 CONSTRUCTION. Shafted screw conveyors shall consist of flighting attached to a pipe shaft. Shaftless screw conveyors shall consist of spiral flighting only. Each screw conveyor shall consist of troughs, covers, bearings, shaft seals, slide gates and operator, drive units, and support structure.

2.3.01 Shafted Screws. Shafted screws shall consist of flights welded to a shaft. Flighting thickness shall be designed for the maximum torque requirements of the equipment. Minimum flight thickness shall be 5/16 inch (8 mm) thick. The pitch of the flights shall meet the performance as specified. The flights shall be mounted to a steel pipe of sufficient diameter so as to maintain a maximum deflection of 1/8 inch (3 mm) between trough ends and any intermediate hanger bearing assemblies.

2.3.02 Shaftless Screws. Spiral flighting for the shaftless screw conveyors shall be designed to convey material without a center shaft. Each screw conveyor shall be provided with an inner spiral to increase axial strength and capacity. Outer flights less than 3/4 inch (19 mm) thickness will require minimum 1/2 inch (12.5 mm) inner flight thickness. Outer flights thickness greater than 3/4 inch (19 mm) will require minimum 5/16 inch (8 mm) inner flight thickness. Minimum flight thickness shall be 5/16 inch (8 mm) thick. The spiral flights shall be designed for the maximum torque requirements of the equipment specified. The "spring effect" of the spiral shall not exceed 30 mils per foot (750 mm/300 mm) of length at maximum load conditions. Flights shall be formed from cold spring steel having a 72,000 psi (496 MPa) tensile strength and a minimum 250 Brinell hardness.

Spiral flighting shall have full penetration welds at all splice connections. The flights shall be aligned to assure true alignment when assembled and shall be made according to the manufacturer's recommendations. The connection of the spiral to the drive system shall be through a flanged connection plate that is welded to the spiral forming a smooth and continuous transformation from the flange plate to the spiral. The drive shaft shall have a mating matching flange and shall be bolted to the spiral connection plate.

2.3.03 Troughs. Troughs shall be U-shaped, minimum 3/16 inch (4.7 mm) thick and shall conform to CEMA 300. Troughs shall be equipped with inlet and discharge flanged connections having a minimum thickness of 5/16 inch (8 mm). The outlet openings in the trough bottom shall be sized to prevent screw conveyor plugging. The portion of each trough that is not covered by the inlet opening shall be covered. Covers shall conform to CEMA 300. The covers shall be manufactured in less than 4 foot (1.1 m) lengths to allow for access. Stiffeners shall be placed across the top of the trough and fastened to both sides of the trough to maintain trough shape and act as a seal face for the covers. A continuous 1 inch (25 mm) thick neoprene gasket shall be applied to entire top face of trough top flange and stiffeners. Wear liners shall cover the bottom 180 degrees of the trough. Wear liners shall be ultra high molecular weight (UHMW) polyethylene. The wear liners shall be manufactured in sections four feet or less to allow for replacement. Holddown bars shall be provided to minimize vertical movement of the flights.

Flushing and drain connections shall be provided. The flushing connection shall be a 1 inch (25 mm) NPT, welded to the side of the trough. The drain connection shall be 4 inch (100 mm) flanged, welded to the end of the trough.

2.3.04 <u>Shaft Seals</u>. Shaft seals shall be waste packing seal with lip type seal or packed gland.

2.3.05 <u>Bearings</u>. The screws shall be supported by antifriction roller bearings that are mounted outboard of the screw conveyor. The bearings shall have a minimum AFBMA B10 life of 50,000 hours. Thrust bearings shall be provided on the drive end of the shafted screw conveyors. Internal hanger bearings shall consist of CEMA 300, Type 226 hangers with greaseable hard iron bearing inserts. The grease lubrication line shall extend through the cover. The bearings shall be furnished with externally accessible grease fittings.

2.3.06 <u>Conveyor Supports</u>. Each conveyor shall be furnished complete with supports suitable for mounting as shown on the drawings and as required by the supplier's design. At a minimum, each screw conveyor trough shall have supports at the drive end and the tail end of the trough plus intermediate supports at a maximum of 12 foot (4 m) intervals. All shop welding shall conform to the latest standards of AWS. The supports shall be designed to avoid interference with other equipment or equipment supports. The supports shall be designed to prevent excessive vibration of any portion of the conveyor unit under all loading conditions.

All structural supporting members shall be designed such that the ratio of the unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (of angles about Z-Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed the AISC allowable stresses by more than 1/3 when subject to loading of twice the maximum design operating torque of the screw conveyor drive motors.

2.3.07 <u>Slide Gates</u>. Slide gates shall be installed on the discharge opening of the screw conveyors. Slide gates shall be constructed of a minimum 1/4 inch (6 mm) thick material. Slide gates shall be capable of being operated from the fully closed position to fully opened position along suitable guide channels. The guide channels and operators shall be suitably supported from the screw conveyor trough. Slide gates shall be actuated as indicated in the Contract Documents.

2.3.08 <u>Fasteners</u>. All bolts, nuts, washers, and other fasteners shall be constructed of stainless steel.

2.4 <u>Drive Units</u>. Each conveyor shall be driven by an electric motor through a chain or belt drive and gear reducer, or be driven directly by a gear reducer. The nominal input power rating of each gear or speed reducer shall be at least equal to the nameplate power rating of the drive motor. Drive units shall be designed for 24 hour continuous service. Gearmotors shall not be used.

2.4.01 Belt Drive. Belt drives shall be either V-belt or cogged timing belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 4 to 1. Each belt drive shall include a sliding base or other suitable means of tension adjustment.

2.4.02 Gear Reducers. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout. Gear reducers shall be AGMA Class II, single or double reduction, helical gear units with high capacity roller bearings. Bearings shall be designed for the thrust loads from the spiral flights and shall have an AFBMA B_{10} life of 100,000 hours. The reducers shall be standard air-cooled units with no auxiliary cooling allowed. The gear housing shall be of 30,000 psi (207 MPa) cast iron, with removable inspection cover(s), oil breather(s), oil level indication, fill and drain holes with plugs; gearing shall be lubricated through an oil bath for the mounting position and inclination. The gear reducer shall be sized with a torque service factor of 1.5 based on motor nameplate, at the driven (output) shaft speed, whichever is greater.

2.4.03 Safety Guards. All belt or chain drives, couplings, and other moving or rotating parts of the conveyors shall be covered on all sides by a safety guard, fabricated from 16 USS gage (1.52 mm thick) or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and shall be furnished complete with all necessary supports and accessories. Supports and accessories, including bolts, shall be galvanized. Safety guards in outdoor locations shall be designed to keep out rain and dripping water.

2.4.04 Electric Motors. The design of the electric motors shall be in accordance with the requirements of Master Specification Section 16220, General Purpose Induction Motors. Gearmotor type speed reducers are not acceptable.

2.5 CONTROLS. Motor starters and all other controls not specified herein shall be furnished under Master Specification Section 16050, Electrical General Requirements.

2.5.01 Accessories. The conveyor shall be provided with the following switches. Switches shall be furnished with standard watertight covered terminal strip junction box and 1/2 inch (12.7mm) threaded conduit connection unless otherwise indicated in the Contract Documents. Each switch shall be furnished and mounted as an integral part of the conveyor equipment and framework. All switches shall have 10 ampere, 115/120 volt ac, 60 Hz, rating.

2.5.02 Zero Speed Switch. A zero speed switch shall be provided on the conveyor to detect loss of speed. The zero speed switch shall be of the noncontacting type. The zero speed switch shall provide a contact output which opens to indicate zero speed and automatically resets or closes when the machine is operating. The zero speed switch shall be coordinated to properly operate over the full speed range of the driven equipment.

2.5.03 Emergency Stop Switches. Screw conveyors shall be equipped with two emergency stop safety switches, each with two normally closed double break contacts. Contacts shall be manually reset. Switches shall be equipped with a latching mechanism and a weight and cable along the length of the conveyor for operation of the switch. Switches shall be opened by cable linkage mounted on all sides of the conveyor. Cables shall be plastic covered metal cable (blaze orange color) and shall be located along the conveyor within easy reach of operating personnel who may be maintaining or observing the operating conveyor. Cable shall be accessible from all conveyor pinch points.

2.6 SHOP PAINTING. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Sharp corners of all cut or sheared edges shall be smoothed by a power grinder.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 ERECTION. Each screw conveyor shall be erected by workers who are regularly engaged in screw conveyor erection and who are acceptable to the equipment manufacturer.

3.2 WIRING. All wiring shall be installed in intermediate metal conduit in accordance with the National Electric Code.

3.3 FIELD QUALITY CONTROL.

3.3.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3.02 Installation Supervision. When indicated in the Contract Documents, the equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the Contract Price.

The manufacturers' installation supervisor shall observe, instruct, guide, and direct the contractor's erection or installation procedures. The equipment manufacturer will be notified in writing 10 working days before for such services are needed.

3.4 TRAINING. When indicated in the Contract Documents, the manufacturer's representative shall provide training for Owner in proper operation and maintenance of the equipment. Such services shall be included in the contract price.

End of Section

SECTION 14553

BELT CONVEYORS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of belt conveyors for the locations as indicated in the Contract Documents.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated and assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

All structural and miscellaneous metal required shall conform to the requirements of Master Specification Section 05120, Structural Steel and Master Specification Section 05500, Metal Fabrications.

The supplier shall review the contract drawings and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow convenient collection of waste oil in containers from the operating area or platform without removing the unit from its normal installed position.

Grease fill openings shall be zerk fittings, buttonhead type, size as determined by Owner.

1.2.03 Abbreviations. Reference to standards and organization in this section shall be by the following designations:

AFBMA	Antifriction Bearing Manufacturers Association
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CEMA	Conveyor Equipment Manufacturers Association
MIOSHA	Michigan Occupational Safety and Health Administration

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, schematic and wiring diagrams, together with detailed specifications and data covering material used, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications for each conveyor shall include, but shall not be limited to, the following:

Belt Conveyors and Accessories

Idlers.

End pulleys.

Takeups.

Belt construction and materials.

Belt speed.

Specifications for materials of construction.

Complete conveyor dimensions and weight.

Support details.

Support dead loads.

Deflector plows. (if required)

Drive

Name of manufacturer.

Type and model.

Type of bearings and lubrication.

Input/output speed.

Net weight.

Service factor at installed horsepower.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as indicated in the Contract Documents. Spare parts shall be suitably packaged in accordance with the handling and storage requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1.6 WARRANTY. After the belt conveyor installation and operation is acceptable to Engineer, the Belt Conveyor Manufacturer shall warrant all equipment for a period of four (4) years. All other details of the warranty shall be in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Equipment provided under this section shall be suitable for the service conditions as indicated in the Contract Documents. Equipment shall conform to the applicable sections of the MIOSHA standards.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and products shall be as specified herein, or shall be equivalent products of manufacturers regularly producing belt conveyors, subject to acceptance by Engineer. All modifications necessary to accommodate the track, hoist, or trolley shall be subject to acceptance by Engineer and shall be made at no additional cost to Owner.

The belt conveyors shall be as manufactured by American Bulk Conveyor, Custom Conveyor, Keystone or approved equal.

2.3 CONSTRUCTION. Each belt conveyor shall track within CEMA standards. The use of training idlers will not be permitted. The conveyor shall be designed so the belt will not lift off the idlers at any time. Maximum belt incline shall be as indicated in the Contract Documents.

2.3.01 Supporting Members. The belt conveyors shall have a rigid supporting framework and shall be supported from the floor.

The belt conveyor frame and support legs shall be fabricated from structural steel members which shall rigidly support all dead loads and live loads. Dead loads to be supported shall include conveyor, belt skirts, deck plates, drip pans, belt cleaner, motor drive, access provisions, and any other accessories required. Live loads shall consist of assumed unit loadings sufficient to provide for movable or transitory loads such as people and portable equipment. The design live load shall be as indicated in the Contract Documents.

The ratio of unbraced length to least radius of gyration (slenderness ratio) shall not exceed 120 for any compression member and shall not exceed 240 for any tension member (for angles about the Z-Z axis). In addition, all structural members and connections shall be designed so that the unit stresses will not exceed AISC allowable stresses by more than one-third when subjected to loading of twice the running torque of the drive motor.

All conveyor supporting members shall be constructed of ASTM A36 steel and shall be hot-dip galvanized steel.

2.3.02 Belts. Conveyor belts shall consist of a carcass, with top and bottom covers. The carcass shall be constructed of nylon or polyester fibers. The number of carcass plies shall be as indicated in the Contract Documents. Covers shall be constructed of nitrile and shall be oil resistant and suitable for temperatures up to 180°F (82°C). The type of conveyor belt splices shall be vulcanized or mechanical splices.

2.3.03 End Pulleys. Pulleys shall be provided on the head and tail ends of the conveyor. End pulleys shall be of welded construction of stainless steel or carbon steel and shall be the crown face type with tapered steel bushings bolted to the hub for securing the pulley on the shaft. Shaft shall be fabricated of stainless steel or high carbon steel. All drive pulleys shall be keyed to the shaft. Bearings shall be the self-aligning, double row roller type mounted in pillow blocks and shall be provided with spring loaded contact seals and grease fittings. End pulleys shall be provided with ceramic lagging. Bearings shall have a minimum life AFBA L_{10} Life Rating of 40,000 hours at specified operating conditions.

2.3.04 Idlers. Idlers shall be constructed in accordance with CEMA "Series C". Idler type and size shall be stainless steel or hot-dip galvanized steel. Bearings shall be the tapered roller type with labyrinth type seals and grease fittings. Bearings shall have a minimum life AFBA L_{10} Life Rating of 40,000 hours at specified operating conditions.

Return idlers shall be the rubber disc type.

2.3.05 Takeups. The conveyor shall be provided with manual or automatic takeups.

Manual takeups shall provide adjustment of at least 2 percent of the distance from center of tail pulley to center of head pulley or a minimum of 12 inches (300 mm). Manual takeups shall be constructed with hot-dip galvanized steel frame, stainless steel screw and brass nut.

Automatic takeups shall be the gravity type consisting of a counter weight attached to the take-up pulley. The take-up pulleys shall be constructed as specified for the end pulleys.

2.3.06 Drip Pans. A drip pan shall be provided beneath the return belt on all sections of each conveyor. The edges of the drip pan shall extend beyond the belt edges at least 2 inches (50 mm) and shall turn up at least 2 inches (50 mm). The drip pan shall be sloped to drains. The drip pans drains shall have a 1-1/2 inch (38 mm) threaded connection to accept hose. Drip pans shall be constructed of hot-dip galvanized steel, AISI Type 304 stainless steel, or AISI Type 316 stainless steel and shall be a minimum 10 gage (3.42 mm) thickness.

2.3.07 Deck Plates. A deck plate shall be provided as part of the conveyor framework and shall be located just below the idlers to prevent spillage onto the underside of the belt below. Deck plates shall be constructed of hot-dip galvanized steel, AISI Type 304 stainless steel, or AISI Type 316 stainless steel and shall be a minimum 10 gage (3.42 mm) thickness.

2.3.08 Fasteners. All bolts, nuts, washers, and other fasteners shall be constructed of stainless steel.

2.4 DRIVE UNITS. Each conveyor shall be driven by an electric motor through a chain or belt drive and gear reducer, or be driven directly by a gear reducer. The nominal input power rating of each gear or speed reducer shall be at least equal to the nameplate power rating of the drive motor. Drive units shall be designed for 24 hour continuous service. Gearmotors shall not be used.

2.4.01 Belt Drive. Belt drives shall be either V-belt or cogged timing belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 4 to 1. Each belt drive shall include a sliding base or other suitable means of tension adjustment.

2.4.02 Gear Reducers. Each gear reducer shall be a totally enclosed unit with oil or grease lubricated, rolling element, antifriction bearings throughout.

Helical, spiral bevel, combination bevel-helical, and worm gear reducers shall have a service factor of at least 1.50 based on the nameplate power rating of the drive motor. Cycloidal gear reducers shall have a service factor of at least 2.0 based on the nameplate power rating of the drive motor. Shaft-mounted and flange-mounted gear reducers shall be rated AGMA Class II. Helical gear reducers shall have a gear strength rating to catalog rating of 1.5. Each gear reducer shall be designed and manufactured in compliance with applicable AGMA standards.

The thermal power rating of each unit shall equal or exceed the nameplate power rating of the drive motor. During continuous operation, the maximum sump oil temperature shall not rise more than 100°F (55°C) above the ambient air temperature in the vicinity of the unit and shall not exceed 200°F (93°C).

Each grease lubricated bearing shall be installed in a bearing housing designed to facilitate periodic regreasing of the bearing using a manually operated grease gun. Each bearing housing shall be designed to evenly distribute new grease, to properly dispose of old grease, and to prevent overgreasing of the bearing. Permanently sealed, grease lubricated bearings will not be acceptable. An internal or external oil pump and appurtenances shall be provided, if required, to lubricate oil lubricated bearings. A dipstick or a sight glass shall be provided on each unit for checking lubricant level. Bearings shall have a minimum life L_{10} Life Rating of 100,000 hours.

Gear reducers which require removal of parts or disassembly of the unit for cleaning and manual regreasing of bearings will not be acceptable.

The gear reducer manufacturer shall certify that they have reviewed the intended application of each unit in detail and that the unit provided is fully compatible with the conditions of installation and service.

2.4.03 Safety Guards. All belt or chain drives, couplings, and other moving or rotating parts of the conveyors shall be covered on all sides by a safety guard, fabricated from 16 USS gage (1.52 mm thick) or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and shall be furnished complete with all necessary supports and accessories. Supports and accessories, including bolts, shall be galvanized. Safety guards in outdoor locations shall be designed to keep out rain and dripping water.

2.4.04 Electric Motors. The design of the electric motors shall be as specified in Master Specification Section 16220, General Purpose Induction Motors. Gearmotor type speed reducers are not acceptable.

2.5 ACCESSORIES.

2.5.01 Grease Pipes. Stainless steel grease tubing and grease fittings shall be extended to accessible locations to facilitate greasing of all bearings while the conveyor is in operation. Tubing shall be ASTM A269, seamless, Grade TP316 with compression type fittings.

2.5.02 Side Skirts. Conveyor side skirts shall be provided as necessary and shall extend above the belt high point as required. Skirts shall have wiping edges constructed of a minimum 60 durometer solid rubber, shall be adjustable to maintain proper clearance with the belt, and shall be supported by brackets from the conveyor frame. Brackets shall be constructed of hot-dip galvanized steel, AISI Type 304 stainless steel, or AISI Type 316 stainless steel.

2.5.03 Belt Cleaner. A belt cleaner shall be provided at the discharge end of the conveyor. Belt cleaners shall consist of a primary cleaner and, when indicated in the Contract Documents, a secondary cleaner. The belt cleaner shall be of the spring tension type. The belt cleaner shall be positioned and adjusted so that material removed from the belt will drop directly into the loading opening. Belt cleaners operating against rollers will not be permitted. Belt cleaner brackets shall be constructed of hot-dip galvanized steel, AISI Type 304 stainless steel, or AISI Type 316 stainless steel. Blades shall be constructed of tungsten carbide, urethane or 80 Durometer rubber and shall be replaceable.

2.5.04 Discharge Chutes. Discharge chutes shall be provided when indicated in the Contract Documents. The chutes shall be of sufficient size whereby material can be transferred without spillage or clogging. Suitable deflector plates shall be attached to the inside of the chutes to limit falling velocities. In addition, shields shall be provided around the discharge end of the chutes to prevent splashing and spillage. Discharge chutes shall be provided with bracing and supports as necessary. Chutes shall be constructed as indicated in the Contract Documents and shall be a minimum 10 gage (3.42 mm) thickness. The interior of the chute shall be lined with 1/4 inch (6 mm) thick UHMW polyethylene and shall be bolted to the chute.

2.5.05 Deflector Plows. Deflector plows shall be provided when indicated in the Contract Documents to remove all material over one side of the conveyor belt. Plows shall be supported from the conveyor frame. Deflector plows shall be of sufficient height to keep the material from going over the top and shall be of heavy rigid construction capable of withstanding the maximum loads anticipated without excess deflection or vibration. A solid slider plate shall be provided on the underside of the belt below each plow.

Liners shall be provided for each plow face plate and slider plate. The liners shall be fastened to the surfaces so the material can be easily removed, material will not be restricted, and conveyor belts will not be damaged. Liners shall be 1/4 inch (6 mm) thick UHMW polyethylene.

In addition to the liner, the plow face plate shall be provided with an adjustable wiping blade. The blade shall maintain a minimum clearance between the plow and the belt and remove material off the belt. Blades shall be constructed of urethane or 80 Durometer rubber and shall be adjustable.

Actuators shall be manual, electric, or pneumatic type and shall be provided with each deflector plow to raise or lower the plows. When the plow is not in use the actuator shall raise the plow high enough to keep from interfering with the material on the conveyor.

2.5.06 Spray Water Header. When indicated in the Contract Documents, a spray water header with nozzles shall be provided to supply process water for washing the return belt. The spray nozzles shall supply process water in the pattern and quantity necessary for the most efficient washing of the belt.

2.5.07 Hoods. When indicated in the Contract Documents, hoods shall be provided to cover the conveyors. Hoods shall be suitable for outdoor installation, shall completely cover the top belt, and shall attach to the conveyor supporting members.

2.6 CONTROLS. Motor starters and all other controls not specified herein shall be furnished under Master Specification Section 16050, Electrical General Requirements.

2.6.01 Switches. The conveyor shall be provided with the following switches as indicated in the Contract Documents. Switches shall be furnished with standard watertight covered terminal strip junction box and 1/2 inch (12.7 mm) threaded conduit connection. Each switch shall be furnished and mounted as an integral part of the conveyor equipment and framework. All switches shall have 10 ampere, 115/120 volt ac, 60 Hz, rating.

2.6.02 Zero Speed Switch. When indicated in the Contract Documents, a zero speed switch shall be provided on the conveyor to detect belt or chain drive breakage. The zero speed switch shall be of the noncontacting type. The zero speed switch shall provide a contact output which opens to indicate zero speed and automatically resets or closes when the machine is operating. The zero speed switch shall be coordinated to properly operate over the full speed range of the driven equipment.

2.6.03 Emergency Stop Switches. Conveyors shall be equipped with two emergency stop safety switches, each with two normally closed double break contacts. Contacts shall be manually reset. Switches shall be equipped with a latching mechanism and a weight and cable along the length of the conveyor for operation of the switch. Switches shall be opened by cable linkage mounted on all sides of the conveyor. Cables shall be plastic covered metal cable (blaze orange color) and shall be located along the conveyor within easy reach of operating personnel who may be maintaining or observing the operating conveyor. Cable shall be accessible from all conveyor pinch points.

2.7 SHOP PAINTING. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Sharp corners of all cut or sheared edges shall be smoothed by a power grinder.

Surfaces to be coated after installation shall be prepared for coating as recommended by the coating manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 ERECTION. Each belt conveyor shall be erected by workers who are regularly engaged in belt conveyor erection and who are acceptable to the equipment manufacturer.

3.2 WIRING. All wiring shall be installed in intermediate metal conduit in accordance with the National Electric Code.

3.3 FIELD QUALITY CONTROL.

3.3.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3.02 Installation Supervision. When required in the Contract Documents, the equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the Contract Price.

The manufacturers' installation supervisor shall observe, instruct, guide, and direct the contractor's erection or installation procedures. The equipment manufacturer will be notified in writing 10 working days before for such services are needed.

3.4 TRAINING. When required, the manufacturer's representative shall provide training for the Owner in proper operation and maintenance of the equipment. Such services shall be included in the contract price for the number of days and round trips to the site as required.

End of Section

SECTION 14621

CHAIN HOISTS

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installation of hand-operated chain hoists, trolleys, proprietary monorail track systems, and accessories as indicated in the Contract Documents.

Hoist runway beams are covered in Master Specification Section 05120, Structural Steel.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Governing Standards. Equipment furnished under this section shall comply with the applicable requirements of the following:

Occupational Safety and Health Standards of the U.S. Department of Labor; Subpart N, Materials Handling and Storage.

ANSI/ASME HST-2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.

ANSI/ASME B30.10, Hooks.

ANSI/ASME B30.11, Monorails and Underhung Cranes.

ANSI/ASME B30.16, Overhead Hoists (Underhung).

ANSI MH27.1, Specifications for Underhung Cranes and Monorail Systems.

MIOSHA Standards

1.2.03 Labels. Each hoist shall have a conspicuous, easy-to-read label showing manufacturer's name and rated capacity of equipment. The rated capacity of the hoist shall also be shown on the load block. Equipment shall be identified by an equipment tag number. Tag number shall be assigned by Owner.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit complete outline and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, in accordance with Master Specification Section 01080, Project Submittals.

1.3..02 Manufacturer's Certification. The hoist manufacturer shall certify that each hoist provided has been load tested in accordance with ANSI/ASME B30.16 with a load of at least 125 percent of the rated load. A certificate shall be submitted for each hoist supplied and shall include the name of the project, the serial number on the hoist, and a description of the test performed. Testing of each hoist shall be the responsibility of the manufacturer and the certification shall be submitted before the hoist will be accepted for the project.

1.3.03 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operation instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data.

Test data and performance curves, where applicable.

A listing of all hoist locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 WARRANTY. The manufacturer shall provide a one (1) year warranty for the hoist and appurtenant equipment in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Service conditions shall be as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Each monorail, hoist, and trolley shall conform to the performance and design requirements as indicated in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and products shall be as specified herein, or shall be equivalent products of manufacturers regularly producing track, hoist, and trolley systems, subject to acceptance by Engineer. All modifications necessary to accommodate the track, hoist, or trolley shall be subject to acceptance by Engineer and shall be made at no additional cost to Owner.

2.3.01 Hoists and Trolleys. The hoists and trolleys shall be as manufactured by Lift-Tech International, P&H, Robbins & Myers, Yale or approved equal.

2.3.02 Monorail Track System. The monorail track system shall be as manufactured by American Monorail, Spanmaster, Twin City Monorail or approved equal.

2.4 HOIST CONSTRUCTION. The hoist and trolley arrangement shall be spur geared type, Army type, or low headroom type.

2.4.01 Spur-Geared Hoisting Assembly. A spur-geared hosting assembly shall consist of an upper block housing the spur gearing, load chain guide, and upper sheaves, and shall be equipped with a top hook for a attachment directly to the trolley; a load chain equipped with a load hook; and hand chains. The top hook shall be arranged to swivel and shall be of forged steel. Anti-friction bearings shall be used throughout, and the assembly shall have suitable fittings for proper lubrication.

2.4.02 Low Headroom Hoisting Assembly. An Army-type, or low headroom hoisting assembly shall consist of the necessary gearing, guides, and sheaves, all built integrally with the trolley; a load chain equipped with a load hook; and hand chains. Anti-friction bearings shall be used throughout, and the assembly shall have suitable fittings for proper lubrication.

2.4.03 Hooks. All hooks shall be slow opening, non-fracturing, forged steel, and shall be provided with a safety latch. The hooks shall be mounted on anti-friction bearings to permit easy turning.

2.4.04 Load Brake. Each hoist shall be equipped with self activating mechanical load brake which will prevent acceleration of the load when lowering and which will sustain the maximum load at any point. Load brakes shall operate in sealed enclosures.

2.4.05 Hoist Chains. Operating chains shall be welded link type, heavily zinc plated. Load chains shall be heat-treated alloy steel. Hand chains shall be steel and shall extend to approximately 3 feet (1 m) above the floor. Chain containers shall be provided to receive idle load chain.

2.5 TROLLEY CONSTRUCTION. Each hoist shall be provided with a trolley of the push type or hand-geared type. Each trolley shall have a rated capacity equal to or greater than the capacity of the corresponding hoist.

Each trolley frame shall be underhung type designed for operation on the specified running track, and shall either contain or support the hoist depending on the hoist/trolley arrangement. Each trolley frame shall be provided with lugs or wrap around side plates on both sides of the track.

Trolley wheels shall be of the single flange type, of rolled, forged, or cast steel, with machined universal crowned or tapered treads. When a hand-geared trolley is specified, the drive wheels shall have integrally cut spur gear teeth or machine-cut gears pressed on hubs.

Wheel axles shall be of the fixed type, made from high carbon steel, machined and ground to size to receive the wheel bearings. Wheel bearings shall be permanently shielded, lifetime-lubricated, anti-friction type, suitable for radial and end thrust loading.

When hook-attached hoists are required, the trolley shall be provided with a lug or crosshead with machined seat to receive the mounting hook of the hoist.

The drive wheels of manually operated, hand-geared trolleys shall be provided with a swinging chain guide which will permit rapid handling of the chain without fouling or gagging and will also permit reasonable side pull on the chain. Operating chains shall be all steel, welded link type, heavily zinc plated.

Operating chains shall extend to approximately 3 feet (1 m) above the floor.

2.6 MONORAIL TRACK SYSTEM. Each proprietary monorail track system shall be furnished complete with monorail track, a track suspension system, and appurtenances indicated on the drawings, specified, or required for a complete, properly operating installation acceptable to Engineer.

2.6.01 Track. The monorail track shall be runway beam track or a proprietary track system. The track shall be capable of supporting the weight of the hoist and trolley and the specified load, plus an impact factor of 25 percent of the specified load, with a limiting deflection of 1/450 of the span between supports.

Joints shall be close-fitting and free from unevenness. The track sections shall be rigidly supported in exact alignment. Where indicated on the drawings, curved sections shall be carefully formed to radius and shall be free of warp and distortion.

Removable stops shall be provided on each end of each monorail track to limit the hoist travel. Stops shall conform to the governing standards, and shall be so located that the hoist does not come into contact with any part of the structure or piping, or encroach on the any clearances indicated on the drawings.

2.6.02 Track Suspension System. The monorail track manufacturer shall furnish the suspension system, which shall consist of all track hangers, hanger rods, clamps, brackets, braces, supports, fasteners, and appurtenances required to support the track system from the structure, as indicated on the drawings. Unless otherwise permitted, track loads shall be applied at the load points indicated and shall not exceed the values indicated on the drawings.

2.6.03 Track Opener. A manually operated track opener shall be provided in the monorail at the location indicated on the drawings. The opener shall include provisions to prevent the hoist trolley from running off the open end of the track when the opener is not in the closed position. Operating chains shall be zinc plated and shall extend to within 3 feet (1 m) of the floor. Suitable hooks shall be provided on the adjacent wall to hold the chains out of the way when the opener is not being operated. In the closed position, the opener shall be suitable for operation of the trolley.

2.6.04 Track Switches. Manually operated track switches for push type trolleys and for hand-geared trolleys (whichever trolley type is specified) shall be provided at the locations indicated on the drawings. Each switch shall include provisions to prevent the hoist trolley from running off the open end of the track when the switch is not in the closed position. Operating chains or ropes shall extend to within 3 feet (1 m) of the floor. In the closed position, the switches shall be suitable for operation of the hoist trolley.

2.7 SHOP PAINTING. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Self-contained or enclosed components shall be shop primed or finished with an oil resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

All other surfaces to be coated after installation shall be prepared for painting as recommended by the coating manufacturer for the intended service, and then shop painted with one or more coats of the specified shop primer.

PART 3 - EXECUTION

3.1 ERECTION. Each hoist and trolley and monorail track system shall be erected by workers who are regularly engaged in hoist and track erection and who are acceptable to the equipment manufacturer. Hoist and monorail installation shall be the responsibility of a single manufacturer.

3.2 FIELD QUALITY CONTROL. When indicated in the Contract Documents, manufacturer's field services shall be provided, which shall consist of an installation check.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Material, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting appurtenances; and has been operated under full load conditions and that it operated satisfactorily.

End of Section

SECTION 14622

ELECTRIC WIRE ROPE HOISTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of electric wire rope hoists, trolleys, proprietary monorail track systems, and accessories as indicated in the Contract Documents.

Hoist runway beams are covered in Master Specification Section 05120, Structural Steel.

Each hoist and monorail track system shall be furnished and installed in the location and arrangement indicated on the drawings, complete with all hoisting equipment, monorail track (when required), electric wiring (including collectors, conductors, and conductor supports), controllers, pendant control station, and all other accessories necessary for a complete and properly operating installation.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are to be provided, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

Equipment furnished under this section shall comply with the applicable requirements of the following:

Occupational Safety and Health Standards of the U.S. Department of Labor; Subpart N, Materials Handling and Storage.

ANSI/ASME HST-4M, Performance Standard for Overhead Electric Wire Rope Hoists.

ANSI/ASME B30.10, Hooks.

ANSI/ASME B30.11, Monorails and Underhung Cranes.

ANSI/ASME B30.16, Overhead Hoists (Underhung).

ANSI MH27.1, Specifications for Underhung Cranes and Monorail Systems.

MIOSHA Standards

1.2.04 Power Supply. Power supply to equipment with motors shall be three phase neutral (TPN), three phase (TPI), or single phase and neutral (SPN). Power supply for controls shall be as required, unless otherwise required for a properly operating system.

1.2.05 Labels. Each hoist shall have a conspicuous, easy-to-read label showing the manufacturer's name and the rated capacity. The rated capacity of the hoist shall also be shown on the load block. Equipment shall be identified by an equipment tag number. Tag number shall be assigned by Owner.

1.2.06 Metal Thickness. Gages specified herein refer to US Standard gage.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, together with detailed specifications, schematic and wiring diagrams, and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project

Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable.

Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of each electrically operated hoist and motor driven trolley, and complete details and information on the power feed system.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160,Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all hoist locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.4.02 Contractor's Qualification. Contractor shall submit qualifications to do the work as indicated in the Contract Documents.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.6 WARRANTY. The manufacturer shall provide a one (1) year warranty for the hoist and appurtenant equipment in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the service conditions as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Each monorail, hoist, and trolley shall be designed for the performance and design requirements as indicated in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and products shall be as specified herein, or shall be equivalent products of manufacturers regularly producing track, hoist, and trolley systems, subject to acceptance by Engineer. All modifications necessary to accommodate the track, hoist, or trolley shall be subject to acceptance by Engineer and shall be made at no additional cost to Owner.

2.3.01 Hoists and Trolleys. The hoists and trolleys shall be as manufactured by Lift-Tech International, P&H, Robbins & Myers, Yale or approved equal.

2.3.02 Monorail Track System. The monorail track system shall be as manufactured by American Monorail, Spanmaster, Twin City Monorail or approved equal.

2.4 HOIST CONSTRUCTION. Each hoist shall be of the type as indicated in the Contract Documents. Each hoist shall consist of an electric motor, a grooved winding drum, and gearing, arranged with the trolley as required. Antifriction bearings shall be used throughout. The winding drum shall have machined grooves designed to receive the full run of hoisting cable without overwrapping. The winding drum shall have right-hand and left-hand grooves to provide True Vertical Lift. The ratio between the diameter of the drum and the diameter of the hoisting cable shall be at least 20 to 1. At least two laps of cable shall remain on the drum when the lifting hook is in the lowest position.

Each hoist shall be protected against the weather and shall be suitable for outdoor operation.

2.4.01 Gears and Bearings. Hoist gearing shall be spur or helical type and shall be fully enclosed in an oiltight housing. All bearings shall be antifriction type, with oil lubrication or lifetime grease packing.

2.4.02 Load Brakes. Each hoist shall be provided with mechanical and electrical load brakes arranged so that the load may be raised or lowered by electric power and automatically sustained at any position of the hook when the power is cut off. The mechanical load brake shall prevent acceleration of the load when lowering and shall completely sustain the load when brought to rest, independent of the electric brake. The electric brake shall be released whenever current is flowing to the hoist motor and shall be automatically activated when the current is shut off or interrupted. The mechanical load brake shall operate in oil in a sealed enclosure.

2.4.03 Limit Switches. Each hoist shall be provided with adjustable limit switches to stop the hoisting mechanism at the upper and lower limits of hook travel.

2.4.04 Lifting Tackle. The lifting tackle shall consist of a lower block and hook, necessary sheaves, and wire rope made especially for hoisting service. Wire rope shall be as recommended by the rope manufacturer for use on the specified drum. The lower block and hook shall be of the safety type, with guarded sheaves and a slow opening, nonfracturing, forged steel hook. The hook shall be supported on a ball or roller thrust bearing for easy turning, and shall include a safety latch. The sheaves shall have antifriction or sleeve type bearings.

2.5 TROLLEY CONSTRUCTION. Each hoist shall be provided with a trolley of the type as indicated in the Contract Documents. Each trolley shall have a rated capacity equal to or greater than the capacity of the corresponding hoist.

The trolley frame shall be rigid, shall support the hoist, and shall be underhung type designed for operation on the specified running track. The trolley frame shall be provided with lugs or wrap around side plates on both sides of the track.

Wheels shall be single flange type, made from rolled, forged, or cast steel, with hardened treads. If a hand-geared or motor-driven trolley is specified, trolley drive wheels shall have integrally cut spur gear teeth or machine-cut gears pressed on the hubs. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

The trolley drive of motor driven trolleys shall be a sealed worm or spur gear unit, permanently lubricated in an oil bath.

The trolley drive wheel of hand-geared trolleys shall be equipped with a swinging chain guide which will permit rapid handling of the chain without fouling or gagging of the wheel and will also permit reasonable side pull on the chain. The operating chain shall be heavily zinc plated and shall extend to approximately 3 feet (1 m) above the operating floor.

Each trolley shall be protected against the weather and shall be suitable for outdoor operation.

Each trolley shall be constructed to provide necessary clearances at all track joints, splices, and hangers, including all projections on any track opener sections and switches.

If curved tracks are indicated, each trolley shall be designed to operate on curved sections having the radii indicated on the drawings.

When a festooned power cord type power system is required, the hoist trolley shall have a suitable member to contact and push the bumper of the adjacent conductor cord trolley.

2.6 MONORAIL TRACK SYSTEM. Each proprietary monorail track system shall be furnished complete with monorail track, a track suspension system, and appurtenances indicated on the drawings, specified, or required for a complete, properly operating installation acceptable to Engineer.

2.6.01 Track. The monorail track shall be capable of supporting the weight of the hoist and trolley and the specified load, plus an impact factor of 25 percent of the specified load, with a limiting deflection of 1/450 of the span between supports.

Joints shall be close-fitting and free from unevenness. Track sections shall be rigidly supported in exact alignment. Where indicated on the drawings, curved sections shall be carefully formed to radius and shall be free of warp and distortion.

Removable stops shall be provided on each end of each monorail track to limit hoist travel. Stops shall conform to the governing standards and shall be so located that the hoist does not come into contact with any part of the structure or piping or encroach on any clearances indicated on the drawings.

When a festooned power cord type power system is specified, the power feed end of the monorail shall have stops designed so that the power cord trolleys will pass beneath the stops. The stops shall be located so that there is sufficient room on the monorail for storage of the cord trolleys beyond the stops. Secondary stops shall be provided for the cord trolleys.

2.6.02 Track Suspension System. The monorail track manufacturer shall furnish the track suspension system, which shall consist of all track hangers, hanger rods, clamps, brackets, braces, supports, fasteners, and appurtenances required to support the track system from the structure, as indicated on the drawings. Unless otherwise permitted, track loads shall be applied at the load points indicated and shall not exceed the values indicated on the drawings.

2.6.03 Track Opener. A manually operated track opener shall be provided in the monorail at each location indicated on the drawings. If electrical systems are in place for the hoist and trolley, the opener shall be equipped with electric conductors compatible with the conductor system specified for the hoist. The opener shall include provisions to prevent the hoist trolley from running off the open end of the track when the opener is not in the closed position. Operating chains shall be zinc plated and shall extend to within 3 feet (1 m) of the floor. Suitable hooks shall be provided on the adjacent wall to hold the chains out of the way when the opener is not being operated. In the closed position, the opener shall be suitable for operation of the trolley.

2.6.04 Track Switches. Manually operated track switches shall be provided at the locations indicated on the drawings. When electrical systems are in place for the hoist and trolley, the switches shall be equipped with electric conductors as specified herein. Each switch shall include provisions to prevent the hoist trolley from running off the open end of the track when the switch is not in the closed position. Operating chains or ropes shall extend to within 3 feet (1 m) of the floor. In the closed position, the switches shall be suitable for operation of the hoist trolley.

2.7 ELECTRICAL.

2.7.01 Motors. Motors shall be totally enclosed, high-starting torque, squirrel-cage type, designed especially for hoist service and suitable for operation on the power supply specified. Motor size and speed shall be adequate to start the fully rated load capacity.

2.7.02 Controllers. Control of hoist and trolley motions shall be from a single pendant push-button station, suspended a distance as required from the bottom of the running track. Controllers shall be of the reversing, magnetic contactor type, with thermal overload protection, and shall be installed at the motor and operated from the pendant station. Trolley controllers shall be provided with ballast resistance for cushioned starting.

The pendant station shall be suspended from the hoist and shall contain individual push buttons for motions of the hoist and trolley.

Push buttons shall be of the mechanical or electrical interlocking type to prevent the possibility of damage to equipment should two or more buttons be depressed simultaneously. Push buttons shall be provided with a spring return to neutral and shall automatically return to the "Off" position when pressure on the button is released.

A control power transformer, with one secondary lead fused and the other grounded, shall be provided to reduce voltage at the push-button station to an amount as required. The pendant control cable shall be heavy-duty type, with extra-flexible stranding and a neoprene jacket. Support for the pendant station shall be provided by a stainless steel wire rope or chain equipped with a suitable strain-relief clamp for the conductor cable. The support shall offset the pendant station at least 2 feet (600 mm) measured horizontally from the centerline of the running track.

The pendant and controls for each hoist shall be protected against the weather and shall be suitable for outdoor operation.

2.7.03 Power Feed System. A complete electric power feed system shall be provided for each hoist, and for the trolleys. The type of system shall be as indicated in the Contract Documents.

2.7.03.01 Cable Reel Power Feed System. When a cable reel power feed system is required, the system shall consist of a spring-loaded cable reel and a suitable power cord. The cable reel shall be installed at the location indicated on the drawings, and shall be of the type and size recommended by the hoist manufacturer. Reel tension shall be sufficient to take up the slack in the power cord when the hoist is moved toward the reel. Each hoist shall be equipped with a strain-relief device for the power cord.

The power cord shall be 600 volt, neoprene jacketed, heavy-duty portable cable, with the number of conductors as required, suitable for wet locations if specified. The power cord shall be rated for hoist and trolley full load amperes at 167°F (75°C) copper temperature.

The feeder circuit for each hoist will be furnished and installed under Master Specification Section 16050, Electrical General Requirements, to the location indicated on the drawings. A suitable junction box with all hanger brackets and other accessories required for a complete installation shall be furnished and installed under this section at the location indicated, and the feeder circuit wired in.

2.7.03.02 Festooned Cable Power Feed System. When a festooned power feed system is required, the power feed system shall consist of a portable power cord festooned in loops from power cord trolleys installed on the bottom flange of the running track. Power cord trolleys shall have ball bearing wheels, a swivelling cord clamp suitable for the size of cord provided, and integral bumpers to prevent contact between the wheels and the hoist or the hoist trolley. A sufficient number of cord trolleys shall be provided to ensure a minimum headroom between the bottom of cord loops and adjacent equipment or the floor, and to permit proper movement of trolleys around curved portions of the running track.

The power cord shall be 600 volt, neoprene jacketed, heavy-duty portable cable with the number of conductors as required, suitable for wet locations if specified. The power cord shall be rated for hoist and trolley full load amperes at 167°F (75°C) copper temperature. A watertight seal connector, of sufficient size to pass full cord diameter, and a woven stainless steel strain-relief grip shall be provided at each end of the cord. Grips shall be aligned parallel to the runway beam and shall not interfere with extension or retraction of the cord. A junction box with cover hub sized for the power cord connection shall be provided at the location indicated on the drawings. The box, mounting, and cover attachment shall be suitable for the maximum applied cord tension.

The feeder circuit for each hoist will be furnished and installed under Master Specification Section 16050, Electrical General Requirements, to the location indicated on the drawings. A suitable junction box with all hanger brackets and other accessories required for a complete installation shall be furnished and installed under this section at the location indicated, and the feeder circuit wired in.

2.7.03.03 Track-Mounted Power Bar Feed System. When a track-mounted power bar feed system is required, each system shall consist of insulated conductors and insulated collector assemblies with copper-graphite collector shoes. The current and voltage rating of the conductors and collectors shall be adequate for the maximum electrical load.

Stationary conductors shall be installed adjacent to the running track switches, and track opener section (if specified), with supports and brackets as needed. Insulated travelling collector assemblies shall be installed on the hoist trolley and wired to the hoist. Conductors and collectors shall be installed in compliance with the recommendations and instructions of the system manufacturer.

If the track extends, via a track opener, to the exterior of the structure, the interior and exterior monorail track sections shall be separately and independently powered, so that the hoist and trolley can be operated on either the interior or exterior monorail with the track opener section either open or closed. The conductor system on the exterior monorail section shall be weatherproof. Curved conductor sections shall be provided where required for a curved monorail track.

The feeder circuit for each hoist will be furnished and installed under Master Specification Section 16050, Electrical General Requirements, to the location indicated on the drawings. A suitable junction box with all hanger brackets and other accessories required for a complete installation shall be furnished and installed under this section at the location indicated, and the feeder circuit wired in.

2.7.04 Wiring. All insulated wire shall be heat-resistant and shall be insulated for 600 volts.

2.8 SHOP PAINTING. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.9 LUBRICATION. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

2.10 SAFETY GUARDS. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.11 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 ERECTION. Each hoist and trolley and monorail track system shall be erected by workers who are regularly engaged in hoist and track erection and who are acceptable to the equipment manufacturer. Hoist and monorail installation shall be the responsibility of a single manufacturer.

3.2 WIRING. All wiring shall be installed in intermediate metal conduit in accordance with the National Electrical Code.

3.3 FIELD QUALITY CONTROL. When indicated in the Contract Documents, manufacturer's field services shall be provided, which shall consist of an installation check.

3.3.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Material, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting appurtenances; and has been operated under full load conditions and that it operated satisfactorily.

End of Section

SECTION 14630

TRAVELING BRIDGE CRANES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of traveling bridge cranes, complete with trolleys and hoists, as indicated in the Contract Documents. This section is applicable for capacities up to 10 tons and spans up to 60 feet.

Runway beams/crane rails are covered in Master Specification Section 05120, Structural Steel.

Each bridge crane assembly shall consist of structural members fabricated by the crane supplier and components (end trucks, wheels, bridge drive mechanism, trolley, and hoist) manufactured by the acceptable manufacturers. Equivalent products of other manufacturers regularly engaged in the production of equipment of this type may be furnished subject to acceptance by Engineer. All modifications necessary to accommodate the equipment shall be subject to review and acceptance by Engineer and shall be made at no additional cost to Owner.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more traveling bridge cranes are to be provided, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer. Similar component parts of bridge cranes shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Each bridge crane assembly shall be preassembled and run in the shop, then matchmarked and disassembled for shipment.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

Equipment furnished under this section shall comply with the applicable requirements of the following:

Occupational Safety and Health Standards of the U.S. Department of Labor; Subpart N, Materials Handling and Storage.

MIOSHA Standards

For top running multiple girder electric overhead cranes:

Crane Manufacturers Association of America (CMAA) Specification No. 70, Specifications for Electric Overhead Traveling Cranes.

For top running and under-running single girder overhead cranes:

Crane Manufacturers Association of America (CMAA) Specification No. 74, Specification for Top Running & Under Running Single Girder Electric Overhead Traveling Cranes.

For underhung electric or manual cranes:

ANSI MH27.1, Specifications for Underhung Cranes and Monorail Systems.

ANSI/ASME HST-2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.

ANSI/ASME HST-4M, Performance Standard for Overhead Electric Wire Rope Hoists.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the Contract Documents. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

1.2.05 Labels. Each bridge, trolley, and hoist shall have a conspicuous, easy-to-read label showing manufacturer's name, crane serial number, and rated capacity. The rated capacity of the hoist shall also be shown on the load block. Equipment shall be identified by an equipment tag number. Tag number shall be assigned by Owner.

1.2.06 Metal Thickness. Gages specified herein refer to US Standard gage.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable.

Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of the traveling carne assembly, and complete details and information of the power feed system.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all crane locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.4.02 Contractor's Qualification. Contractor shall submit qualifications to do the work as indicated in the Contract Documents.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.6 WARRANTY. The manufacturer shall provide a one (1) year warranty for the bridge crane and appurtenant equipment in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the service conditions as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Each traveling bridge crane shall be designed for the performance and design requirements as indicated in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS. The bridge crane shall be as specified herein and shall be as manufactured by Lift-Tech International, P&H, Robbins & Meyers, Wright, or approved equal.

2.4 HOISTS AND TROLLEYS. Hoist and trolley manufacturers and model numbers shall be as indicated in the Contract Documents. The hoist and trolley arrangement shall be as required. Each hoist and trolley shall be manual or electric as indicated in the Contract Documents.

Manual hoists and trolleys shall be furnished with operating chains which shall be welded link type, heavily zinc plated steel. Chain-operated drive wheels shall be provided with a swinging chain guide which will permit rapid handling of the chain without fouling or gagging and will also permit reasonable side pull on the chain. Operating chains shall extend to approximately 3 feet (1 m) above the floor. The maximum chain pull required at the rated capacity shall be 80 pounds (350 N).

2.4.01 Hoists. The hook shall be a slow opening, non-fracturing, forged steel type with a safety latch. The hook shall be mounted on a ball or roller thrust bearing for easy turning.

2.4.02 Manual. Manually operated hoists shall be spur-geared. Each hoist shall be equipped with a self-activating, mechanical load brake which will prevent acceleration of the load when lowering and which will sustain the maximum load at any point. Load brakes shall operate in sealed enclosures.

Load chains shall be heat-treated alloy steel, welded link type, heavily zinc plated. Chain containers shall be provided to receive idle load chain. Antifriction bearings shall be used throughout, and the assembly shall have facilities for proper lubrication.

If the hoist is hook-attached to the trolley, the hoisting assembly shall consist of an upper block housing the spur gearing, load chain guide, and upper sheaves, and shall be equipped with a top hook for attachment directly to the trolley; a load chain equipped with a load hook; and operating chains. The top hook shall be arranged to swivel and shall be of forged steel.

If the hoist is built integrally with the trolley, the hoisting assembly shall consist of the necessary gearing, guides, and sheaves, all built integrally with the trolley; a load chain equipped with a load hook; and operating chains.

2.4.03 Electric. Electric hoists shall consist of a single-speed electric motor, a grooved winding drum, and gearing. Antifriction bearings shall be used throughout. The winding drum shall have machined grooves designed to receive the full run of hoisting cable without overwrapping. The hoists shall be provided with True Vertical

Lift. The ratio between the diameter of the drum and the diameter of the hoisting cable shall be at least 20 to 1. At least two laps of cable shall remain on the drum when the lifting hook is in the lowest position.

Hoist gearing shall be spur or helical type and shall be fully enclosed in an oiltight housing. All bearings shall be antifriction type, with oil lubrication or lifetime grease packing.

The hoist shall be provided with mechanical and electrical load brakes arranged so that the load may be raised or lowered by electric power and automatically sustained at any position of the hook when the power is cut off. The mechanical load brake shall prevent acceleration of the load when lowering and shall completely sustain the load when brought to rest, independent of the electric brake. The electric brake shall be released whenever current is flowing to the hoist motor and shall be automatically activated when the current is shut off or interrupted. The mechanical load brake shall operate in oil in a sealed enclosure.

The hoist shall be provided with adjustable limit switches to stop the hoisting mechanism at the upper and lower limits of hook travel.

The lifting tackle shall consist of a lower block and hook, necessary sheaves, and wire rope, made especially for hoisting service. Wire rope shall be as recommended by the rope manufacturer for use on the specified drum. The lower block shall be of the safety type, with guarded sheaves. The sheaves shall have antifriction or sleeve type bearings.

2.4.04 Trolleys. The trolley frame shall be rigid. The trolley and bridge arrangement shall be as required. For underhung type trolleys, the trolley frame shall be provided with lugs or wrap around side plates on both sides of the bridge. Wheels shall be double flange type for top-running trolleys, and single flange type for underhung trolleys. Wheels shall be made from rolled, forged, or cast steel, machined universal crowned or tapered treads. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

2.4.05 Manual. The trolley shall be hand geared or push-type.

For hand geared trolleys, drive wheels shall have integrally cut spur gear teeth or machine-cut gears pressed on hubs. Wheel axles shall be of the fixed type, made from high carbon steel, machined and ground to size to receive the wheel bearings. If a hook-attached hoist is specified, the trolley shall be provided with a lug or a crosshead with machined seat to receive the mounting hook of the hoist.

2.4.06 Electric. The trolley drive shall be a sealed worm or spur gear unit, permanently lubricated with an oil bath. Each trolley shall be provided with a brake conforming to the governing standards. Drive wheel treads shall be hardened.

The trolley speed at the rated capacity shall be 40-60 fpm (200-300 mm/s).

2.5 BRIDGES. Each bridge shall be single or double girder type, shall be rigidly supported by end trucks, and shall operate on a running surface. The bridge shall be constructed to accommodate the type of trolley specified. When underhung trolleys are specified, the wearing surface of the bridge's lower flanges shall be either specially fabricated flanges or standard flanges ground smooth.

Steel design and fabrication shall comply with applicable portions of the specifications of the American Institute of Steel Construction. Loadings, impact allowances, and allowable stresses shall be in accordance with the governing standards. Deflection of the main girder shall not exceed 1/800 of the span, with the maximum hoist load at any point.

2.5.01 End Trucks. End trucks, each fabricated from structural steel members, shall be designed to distribute the loading equally to each wheel, shall be securely attached to the beam by welding or with fitted bolts in reamed holes, and shall be provided with heavy gusset plates to ensure adequate rigidity and squareness. Each truck shall have heavy end plates to engage the stops located on the specified running surface. End trucks shall have a wheelbase of approximately 1/7 the bridge span. Underhung end trucks shall be provided with lugs or wrap around side plates on both sides of the track.

The end trucks and wheels shall be designed to operate on the specified running surface, and shall clear all fittings, anchors, and splices located on, or near, that surface.

2.5.02 Wheels. Bridge crane wheels shall be made of rolled, forged, or cast steel, with machined universal crowned or tapered hardened treads, designed to operate on the specified running surface. Drive wheels in each truck shall have integrally cut spur gear teeth, or machine-cut gears pressed on hubs. The other wheels in each truck shall be idlers. Axles may be either rotating or fixed type. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

For top running bridges, each end truck shall have double flange wheels and one drive wheel. For underhung bridges, each end truck shall have single flange wheels and one pair of drive wheels.

2.5.03 Bridge Drive Mechanism. The bridge shall be either manually or electrically driven. Gearing shall be helical, spur, or herringbone type, made from rolled or cast steel, and shall have machine-cut teeth. All shafts shall be made from alloy steel and shall be heat treated.

2.5.04 Manual. The bridge drive shall consist of a cross shaft connected to the drive wheel(s) of each end truck and a chain operated drive wheel. The cross shaft shall be designed to withstand torsional strain and shall be supported by brackets and self-aligning bearings at intervals sufficient to prevent distortion of the shaft. Bearings shall be lifetime-lubricated, antifriction type.

The drive wheel shall be equipped with a swinging chain guide which will permit rapid handling of the chain without fouling or gagging the wheel and will also permit reasonable side pull on the chain. The operating chain shall be heavily zinc plated and shall extend to approximately 3 feet (1 m) above the floor. The drive chain for the bridge shall be located as indicated in the Contract Documents. The maximum chain pull required at the rated capacity shall be 80 pounds (350 N).

2.5.05 Electric. The bridge drive shall consist of a single speed electric motor, or a specially designed dual speed electric motor, as required, enclosed reduction gearing, and a cross shaft connected to the drive wheel(s) of each end truck. The shaft shall be designed to withstand torsional strain and shall be supported with self-aligning, lifetime-lubricated bearings at intervals sufficient to prevent distortion of the shaft.

The drive motor shall contain a built-in adjustable mechanical brake. The bridge brake shall be solenoid operated, adjustable shoe or disc type, acting directly on the bridge drive motor shaft.

The bridge speed at the rated capacity shall be 50-75 fpm (250-380 mm/s).

2.6 BUMPERS AND STOPS. Bumpers and stops in compliance with the governing standards shall be installed on the bridge, trolley, and the specified running surface. The bumpers and stops shall be located so that no part of the bridge or trolley encroaches on the clearances specified or indicated on the drawings.

2.7 ELECTRICAL.

2.7.01 Motors. Motors shall be high-starting torque, squirrel-cage, totally enclosed type, designed especially for crane and hoist service and suitable for operation on the power supply specified. Motor size and speed shall be adequate to start the fully rated load capacity.

2.7.02 Controllers. Control of all electric hoist, trolley, and bridge motions shall all be from a single pendant push-button station. Controllers shall be of the reversing, magnetic contactor type, with thermal overload protection, and shall be installed at the motor and operated from the pendant station. Bridge and trolley controllers shall be provided with ballast resistance for cushioned starting.

The pendant shall contain a separate push button for each of the following motions: off, on, hoist up and down (when electric hoists are specified), trolley forward and reverse (when electric trolleys are specified), and bridge forward and reverse (when electric bridges are specified). The pendant shall be mounted as indicated in the Contract Documents. Push buttons shall be of the interlocking type to prevent possibility of damage to equipment should two or more buttons be depressed simultaneously. Push buttons shall be provided with a spring return to neutral and shall automatically return to the off position when pressure on the button is released. A control power transformer with one secondary lead fused and the other grounded shall be provided to reduce voltage at the push-button station to a maximum of 120 volts. The pendant control cable shall be heavy-duty type with extra-flexible stranding and neoprene jacket. Support for the pendant station shall be provided by a stainless steel wire rope or chain equipped with a suitable strain-relief clamp for the conductor cable.

2.7.03 Power Feed System. When any part of the crane system is electrically operated, a complete electric power feed system shall be provided. The system shall consist of insulated conductors and insulated collector assemblies with copper-graphite collector shoes, and shall be U-S Safety Trolley's "Span-Guard" or "Duct-O-Bar". The conductors shall be the completely enclosed type. The current and voltage rating of the conductors and collectors shall be not less than 90 amperes continuous duty, 135 amperes intermittent duty.

Stationary conductors shall be installed adjacent to the runway, with supports and brackets as needed. Cross conductors shall be supported by angles across the top of the bridge. Collectors for hoist operation shall be installed on the hoist trolley and wired to the hoist. Conductors and collectors shall be installed in conformity with the recommendations and instructions of the system manufacturer.

The feeder circuit for the crane assembly will be furnished and installed under Master Specification Section 16050, Electrical General Requirements, to the location indicated on the drawings. A suitable surface-mounted junction box, with all hanger brackets and other accessories required for a complete installation, shall be furnished and installed under this section at the location indicated, and the feeder circuit wired in.

2.7.04 Wiring. All insulated wire shall be heat resisting and shall be insulated for 600 volts.

2.8 SHOP PAINTING. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, as recommended by the manufacturer.

2.9 LUBRICATION. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

2.10 SAFETY GUARDS. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.11 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 ERECTION. Each crane, hoist, and trolley shall be erected by workers who are regularly engaged in crane erecting and who are acceptable to the crane manufacturer. The orientation of installation of the hoist and trolley on each crane bridge shall be as directed by the Engineer.

3.2 WIRING. All wiring shall be installed in intermediate metal conduit in accordance with the National Electrical Code.

3.3 INSPECTION AND TESTING. After complete assembly and installation, each crane shall be subject to an installation check as specified herein, and an acceptance test. A manufacturer's representative shall be present during all field inspection and testing. The inspection and testing shall verify that each crane has been assembled properly and that all required adjustments have been made.

3.3.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting appurtenances; and has been operated under full load conditions and that it operated satisfactorily.

3.3.02 Acceptance Testing. Each crane shall be subject to operational and rated load testing.

Each crane shall raise, lower, hold in any position, and transport a test load equal to 125 percent of the rated capacity of the crane, with no detrimental effects on the crane. All motions shall be executed satisfactorily. Contractor shall provide the test weights.

The following functions shall be tested:

Hoisting and lowering.

Trolley travel.

Bridge travel.

Limit switches, locking and safety devices.

The trip setting of hoist limit switches shall be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch shall be located to trip the switch, under all conditions, in sufficient time to prevent contact of the hook or hook block with any part of the trolley.

Hoisting and lowering tests will be conducted with 0, 50, 100, and 125 percent of the nominal or rated load.

The rated load test shall consist of the following operations:

The test load shall be lifted a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes.

The test load shall be transported by means of the trolley for the full length of the bridge.

The test load shall be transported by means of the bridge for the full length of the runway in one direction with the trolley as close to the extreme right-hand end of the crane as practical and in the other direction with the trolley as close to the extreme left-hand end of the crane as practical.

The test load shall be lowered, stopped, and held with the brakes.

Wiring shall be given an insulation resistance test using a 500 volt megger.

Following completion of the tests, each crane shall be inspected by Contractor and the manufacturer's representative, in the presence of Engineer, for misalignment, breakage, and undue wear. All deficiencies shall be corrected by Contractor in a manner acceptable to Engineer.

3.3.03 Test Reports. Field inspection and testing of each crane shall be documented by the crane manufacturer's representative through Contractor, noting the deficiencies and corrections and certifying that each crane is acceptable for operation. Certification of the inspection shall be submitted to Engineer.

End of Section

SECTION 14641

PORTABLE GANTRY CRANES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of portable gantry cranes, complete with jacks, cart kits, hoists and trolleys, and all other accessories necessary for a complete and operating system, as indicated in the Contract Documents.

1.2 GENERAL. Equipment and accessories furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, Engineering data, instructions, recommendations of the equipment manufacturer, and local, state and federal codes, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Governing Standards. Equipment provided under this section shall comply with the applicable requirements of the following:

> Occupational Safety and Health Standards of the U. S. Department of Labor; Subpart N, Materials Handling and Storage.
>
> Monorail Manufacturers Association (MMA) Specifications for Underhung Cranes and Monorail Systems.
>
> Hoist Manufacturer Institute HMI 200, Specifications for Hand Operated Chain Hoists.
>
> ANSI B30, Safety Standards for Cranes, Derricks, Hoists, Hooks, Jacks, and Slings.
>
> MIOSHA Standards

1.2.03 Labels. The portable gantry crane and hoist shall have a conspicuous, easy to read label showing manufacturer's name and rated capacity of equipment. Equipment shall be identified by an equipment tag number. Tag number shall be assigned by Owner.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.6 WARRANTY. The manufacturer shall provide a one (1) year warranty for the portable gantry crane and appurtenant equipment in accordance with Master Specification Section 01170, Warranties and Bonds.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the service conditions as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Loading, impact allowances and allowable stresses shall be in accordance with the governing standards. The lifting frame shall have a safety factor of at least 1.5, and the deflection under design load shall not exceed 1/360 of the span.

The lifting frame, hoist, and trolley shall be designed for the conditions as indicated in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS. Each portable gantry crane, hoist, and trolley shall be furnished by Wallace. Equivalent products of other manufacturers regularly engaged in the production of equipment of this type may be furnished subject to acceptance by Engineer.

2.4 PORTABLE LIFTING FRAME. The portable lifting frame shall be of the gantry, A-frame type. The height shall be fully adjustable in 6 inch (150 mm) intervals and shall be locked on each leg by a spring-loaded bolt equipped with a safety notch. Locks shall be designed to allow locking each leg in an unbolted position to facilitate height adjustment. The spread width shall be adjustable with a minimum of six different positions at 6 inch (150 mm) intervals. A cable shall be provided between each set of adjustable legs to prevent overextension. The distance between the A-frames shall be adjustable up to the maximum distance specified.

2.4.01 Monorail. The monorail shall be designed to align with off-center loads to prevent lifting frame and trolley distortion. The monorail shall be suspended from the lifting frame by a minimum of four points at each end of the monorail. A lifting U-bolt shall be provided on top of the monorail at mid-span to facilitate height adjustment.

2.4.02 Casters. Four casters shall be provided, each capable of rotating 360 degrees with a four-position swivel lock. Each caster shall be held to the lifting frame by a bolt secured with a safety chain. The lock on each caster shall prevent rolling and swiveling of the caster when engaged. Each caster shall have a diameter of 6 inches (150 mm).

2.5 HOIST.

2.5.01 Hoisting Assembly. The hoisting assembly shall consist of the necessary gearing, guides, and sheaves, all built integrally with the trolley; a load chain equipped with a load hook; and hand chains. Antifriction bearings shall be used throughout, and the assembly shall have suitable fittings for proper lubrication.

2.5.02 Hooks. The load hook shall be slow opening, nonfracturing, forged steel, and shall be provided with a safety latch. The hooks shall be mounted on antifriction bearings to permit easy turning.

2.5.03 Load Brake. The hoist shall be equipped with a self-activating, mechanical load brake which will prevent acceleration of the load when lowering, and which will sustain the maximum load at any point. Load brakes shall operate in sealed enclosures.

2.5.04 Hoist Chains. Operating chains shall be welded link type, heavily zinc plated. Load chains shall be heat-treated alloy steel. Hand chains shall be steel and shall extend to approximately 3 feet (900 mm) above the floor. Chain containers shall be provided to receive idle load chain.

2.6 TROLLEY. The trolley shall be handgeared type. The trolley shall have a rated capacity equal to or greater than the corresponding hoist capacity.

The trolley frame shall be rigid, shall contain the hoist, and shall be underhung type designed for operation on the specified runway beam. The trolley frame shall be provided with lugs or wrap around side plates on both sides of the track.

Trolley wheels shall be of the single flange type of rolled, forged or cast steel with machined universal crowned or tapered treads. Drive wheels shall have integrally cut spur gear teeth or machine cut gears pressed on hubs.

Wheel axles shall be of the fixed type, made from high carbon steel machined and ground to size to receive the wheel bearings. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, suitable for radial and end thrusting loading.

The drive wheels of manually operated, hand geared trolleys shall be provided with a swinging chain guide which will permit rapid chain handling without fouling or gagging and also permit reasonable side pull on the chain. Operating chains shall be all steel welded link type, heavily zinc plated. Operating chains shall extend to approximately 3 feet (900 mm) above the floor.

2.7 ACCESSORIES.

2.7.01 Cart. The portable gantry crane shall be provided with a 1 ton (910 kg) capacity cart consisting of two steel bridges. The bridges shall be designed to fit into the lifting frame caster sections to provide a portable cart capable of transporting all of the crane components and equipment. The cart with the disassembled crane components shall be able to pass through a 3 feet (900 mm) wide by 6 feet (1800 mm) high opening.

2.7.02 Jacks. Four steel jacks designed to fit the portable gantry crane shall be furnished. The jacks shall be used to adjust the portable gantry crane height and caster spread.

2.8 SHOP COATINGS. All iron and steel surfaces of the equipment shall be protected with suitable coatings applied in the shop. Coatings shall be suitable for the environment where the equipment will be used. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

All coated surfaces shall receive at least three coats of epoxy enamel, at a minimum dry film thickness (DFT) of 5 mils (125 μm) each. The total DFT of the epoxy enamel shall be at least 15 mils (375 μm). An aliphatic polyurethane topcoat shall be applied after complete drying and curing of the epoxy enamel. The aliphatic polyurethane shall be applied in a single coat and shall have a minimum DFT of 2 mils (50 μm).

All coatings shall be continuous and free from gaps, pinholes, thin spots, and other defects. Special attention shall be given to corners, edges, bolts, and weld cleaning to assure adequate coatings in all areas.

Color shall be manufacturer's standard which is acceptable to Owner.

Acceptable coating products shall be as follows:

Epoxy Enamel	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series 69 Hi-Build Epoxoline II".
Aliphatic Polyurethane	Ameron "Amercoat 450HS", Carboline "Carbothane 134HG", or Tnemec "Series 74 Endura-Shield".

2.9 SAFETY GUARDS. All belt or chain drives, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.10 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 ASSEMBLY. The portable gantry crane, complete with accessories, shall be fully assembled, lubricated as needed and placed in proper operating condition to the satisfaction of Engineer.

End of Section

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SECTION 15005

MECHANICAL DEMOLITION

PART 1 – GENERAL

1.1 SCOPE. Perform all HVAC, demolition required for removal of systems and equipment made obsolete by project as indicated on the drawings and as specified herein.

Work Included:

Non-destructive and selective removal of systems, materials, and equipment for reuse or salvage as directed by the Owner and as requested by the Engineer.

Removal and legal disposal of all debris.

Removal of all obsolete materials and equipment for a clean and finished installation, unless noted otherwise on the drawings.

Removal of existing heating and ventilating (H&V) equipment and piping as shown on contract documents and as required in field if not shown on contract documents.

The existing heating and ventilating (H&V) demolition work shall include demolition of controls, exhaust fans, louvers, ductwork, existing steam/condensate piping as shown on plans and as specified here. This, therefore, will require selective removal/demolition and capping at the mains.

The Contractor shall cap existing piping that is not being reused as shown on plans or as required.

The HVAC Contractor to remove existing thermostats and conduits as required and patch openings. Match finish with existing finish.

The HVAC Contractor shall perform demolition of respective systems and all cutting/patching of holes and restoration of all surfaces (floors, walls, ceilings, roof, etc.) to match with existing adjacent surfaces as clearly as possible as to texture and finish.

The cutting/patching shall be done by craftsman skilled in particular trade affected by demolition.

Insulation or materials shall be identified before attempting any demolition. Contractor shall comply with the requirements of EPA regulations, National Emissions Standards, and the OSHA regulations, as well as applicable State laws and City Codes and Ordinances.

1.2 GENERAL. Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.3 JOB CONDITIONS.

1.3.01 Coordination. Adjacent buildings will be required to remain in operation and utility services will be required to be maintained for operations in those buildings.

1.3.02 Phasing. Prior to commencing demolition in any area of the work, notify the Owner/Architect seven days in advance to ensure that no adjacent occupied buildings will be disrupted. All shutdowns, if required, shall be scheduled with the utility companies. Where shutdowns are not permitted during weekdays/working hours, the Contractor shall do such work on the weekends or after working hours. All such costs for premium time shall be included in the bid. Refer to phasing plans in the bidding documents before starting work.

Demolition phasing must be approved by the Owner prior to commencement of the operations.

Removal of debris and construction traffic will be limited to specified areas.

Demolition and installation phasing shall be worked out by the Contractor to maintain existing services to other buildings on site.

1.3.03 Codes. In addition to complying with all pertinent codes and regulations, comply with the requirements of those insurance carriers providing coverage for this work.

1.3.04 Burning. On site burning shall not be permitted.

During the execution of the work, primary consideration shall be given to the protection from damage to the structure, furnishings, finishes, and the like that are not specifically indicated to be removed and disposed.

Provide and maintain temporary partitions or dust barriers adequate to keep dirt, dust, noise, and other particles from being transferred to adjacent areas.

Existing items or surfaces to remain that are damaged as a result of this work shall be refinished, repaired, or replaced to the satisfaction of the Owner at no additional cost.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Patching. All materials used for patching shall be in conformance with the applicable sections of the specifications. Where materials are not specifically described, but require for proper completion of the work, they shall be as selected by the Contractor subject to approval by the Owner.

PART 3 - EXECUTION

3.1 DEMOLITION.

3.1.01 Site Inspection. The drawings do not show all materials or equipment existing on the project that will require demolition.

Before commencing the work of this section, the Contractor shall check with the Owner about materials, and equipment to be removed and those to be preserved. All those items requiring demolition shall be hauled away from site.

3.1.02 Scheduling. Schedule all work with all necessary considerations for public and adjacent areas.

Avoid interference with the use of and passage to and from adjacent areas.

Schedule all work so as not to interfere with nor disrupt Owners continuous operation of other areas of the facility.

All piping/ductwork that are partly removed and are required for making connections to new piping and ductwork shall be temporarily capped until new connections are made.

3.1.03 Abandoned Materials and Equipment. Items so indicated on drawings to be removed and not indicated or specified to be saved or retained shall be demolished, removed, demounted, or disconnected in the best possible manner to ensure that no damage will result to other adjacent items or surface to remain.

3.1.04 Salvage. During removal of items so indicated, caution shall be used to eliminate damage to any equipment having salvage value.

All material being removed shall become the property of the Contractor for disposal unless otherwise noted or directed. Deliver any such item retained by the Owner to any location on the project site as indicated by the project manager.

3.1.05 Disposal and Clean Up. Areas in which demolition and salvage work is being done shall be cleaned daily.

All dirt, dust, debris, unsalvageable and unreusable items and the like shall be totally removed from the project site on a daily basis. Under no circumstances shall such refuse be allowed to collect for longer periods.

Refuse shall not be allowed to block, or otherwise impair circulation in sidewalks or other traffic areas.

End of Section

SECTION 15006

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of mechanical identification materials for the mechanical equipment, piping and ducts as indicated in the contract documents:

Equipment nameplates.

Equipment markers.

Equipment signs.

Access panel and door markers.

Pipe markers.

Duct markers.

Valve tags.

1.2 SUBMITTALS. Submit a shop drawing of each type of product indicated above for engineer's approval.

Submit a typewritten valve schedule for each piping system, reproduced on 8 1/2 inch by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in the schedule margin.

Submit samples of each color, lettering style, and other graphic representation required for each identification material or system. Provide a mock-up type sample installation.

1.3 QUALITY ASSURANCE.

1.3.01 ASME Compliance. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES.

2.1.01 Equipment Nameplates. Metal, with data engraved or stamped, for permanent attachment on equipment.

Data:

Manufacturer, product name, model number, and serial number.

Capacity, operating and power characteristics, and essential data.

Labels of tested compliances.

Location:

Accessible and visible.

Fasteners:

As required to mount on equipment.

2.1.02 Equipment Markers. Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

Terminology:

Match schedules as closely as possible.

Data:

Name and plan number.

Equipment service.

Design capacity.

Other design parameters such as pressure drop, entering and leaving conditions, and speed.

Size:

2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.1.03 Equipment Signs. ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

Data:

Instructions for operation of equipment and for safety procedures.

Engraving:

Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

Thickness:

1/8 inch, unless otherwise indicated.

Fasteners:

Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.1.04 Access Panel and Door Markers. 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

Fasteners:

Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES.

2.2.01 Manufactured Pipe Markers, General. Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

Colors:

Comply with ASME A13.1, unless otherwise indicated.

Lettering:

Use piping system terms indicated and abbreviate only as necessary for each application length.

Pipes with OD, Including Insulation, Less Than 6 Inches:

Full-band pipe markers extending 360 degrees around pipe at each location.

Pipes with OD, Including Insulation, 6 Inches and Larger:

Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

Arrows:

Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

2.2.02 Pre-tensioned Pipe Markers. Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

2.2.03 Shaped Pipe Markers. Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.2.04 Self-Adhesive Pipe Markers. Plastic with pressure-sensitive, permanent-type, self-adhesive back.

2.2.05 Plastic Tape. Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES.

2.3.01 Duct Markers. Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS.

2.4.01 Valve Tags. Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

Material: 0.032-inch- thick brass.

Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 ACCEPTABLE MANUFACTURERS. Identification materials shall be manufactured by All Systems, Inc., Brady (W.H.) Co., Marking Services, Inc., Seton Name Plate Corp., or equal.

PART 3 – EXECUTION

3.1 APPLICATIONS, GENERAL. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is installer's option.

3.2 EQUIPMENT IDENTIFICATION.

3.2.01 Equipment Nameplates. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

Pumps, compressors, chillers, condensers, and similar motor-driven units.

Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

Fans, blowers, primary balancing dampers, and mixing boxes.

Heating and ventilation central-station and zone-type units.

3.2.02 Equipment Markers. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

Letter Size:

Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Data:

Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

Location:

Locate markers where accessible and visible. Include markers for the following general categories of equipment:

Main control and operating valves, including safety devices and hazardous units such as gas outlets.

Meters, gages, thermometers, and similar units.

Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

Pumps, compressors, chillers, condensers, and similar motor-driven units.

Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

Fans, blowers, primary balancing dampers, and mixing boxes.

Heating and ventilation central-station and zone-type units.

Tanks and pressure vessels.

Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.2.03 Equipment Signs. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

Color:

Identify mechanical equipment with equipment markers in the following color codes:

Green: For cooling equipment and components.

Yellow: For heating equipment and components.

Green and Yellow: For combination cooling and heating equipment and components.

Brown: For energy-reclamation equipment and components.

Letter Size:

Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Data:

Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

Include signs for the following general categories of equipment:

Main control and operating valves, including safety devices and hazardous units such as gas outlets.

Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

Pumps, compressors, chillers, condensers, and similar motor-driven units.

Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

Fans, blowers, primary balancing dampers, and mixing boxes.

Heating and ventilation central-station and zone-type units.

Tanks and pressure vessels.

Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.2.04 Access Panel Markers. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION.

3.3.01 Manufactured Pipe Markers. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.

Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

Near each valve and control device.

Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

Near penetrations through walls, floors, ceilings, and non-accessible enclosures.

At access doors, manholes, and similar access points that permit view of concealed piping.

Near major equipment items and other points of origination and termination.

Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION.

3.4.01 Duct Markers. Install duct markers with permanent adhesive on air ducts in the following color codes:

Color:

Green: For cold-air supply ducts.

Yellow: For hot-air supply ducts.

Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

Letter Size:

Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.5.01 Valve-Tag Application Schedule. Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

Valve-Tag Size and Shape:

Cold Water: 1-1/2 inches, round.

Hot Water: 1-1/2 inches, round.

Steam & Condensate: 1-1/2 inches, round.

Valve-Tag Color:

Cold Water: Blue

Hot Water: Red

Letter Color:

Cold Water: Black.

Hot Water: Black.

3.6 ADJUSTING AND CLEANING. Relocate mechanical identification materials and devices that have become visually blocked by other work.

Clean faces of mechanical identification devices and glass frames of valve schedules.

End of Section

SECTION 15010

VALVE INSTALLATION

PART 1 - GENERAL

1.1 SCOPE. This section covers the installation of new valves and actuators purchased by Contractor as part of this Work, or purchased by others under the procurement specifications. The equipment to be furnished by others for installation by Contractor is identified in the applicable valve schedules.

Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

1.2 GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Any valves and actuators that are identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

Contractor shall determine the number of handwheel turns to close each manual valve and shall provide a type 316 stainless steel nameplate, attached to the operator, to indicate the required turns. Contractor shall also submit to Engineer, a table, indicating the number of turns required for each manual valve provided.

1.2.01 Coordination. When manufacturer's field services or installation check services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services.

Submittals for equipment that will be furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

Flanged connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section.

1.3 DELIVERY, STORAGE, AND HANDLING.

1.3.01 Storage. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and the manufacturer's instructions until installed in the Work. Stored equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come into contact with earth or grass. Contractor shall keep the equipment dry at all times.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSPECTION. All valves and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 INSTALLATION.

3.2.01 General. Valves shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.

Unless otherwise indicated on the drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches (1.3 m) or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of piping having centerline elevations between 4 feet 6 inches (1.3 m) and 6 feet 9 inches (2 m) above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation, as reviewed by Engineer.

3.2.02 Installation Checks. When specified in Master Specification Section 15010, Valve Installation, installation checks will be provided by a manufacturer's representative in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Such services shall be furnished at no charge to Contractor for the extent indicated in the valve procurement sections. Any additional services in connection with the installation the equipment which are required by reason of Contractor's progress shall be paid for by Contractor.

Contractor shall perform no Work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

3.2.03 Butterfly Valves. Butterfly valves shall be installed with the shaft horizontal unless otherwise necessary for proper operation or as acceptable to Engineer.

Whenever an actuator must be removed to permit installation of a valve, the actuator shall be promptly reinstalled and shall be inspected and readjusted by a representative of the valve manufacturer.

3.2.04 Check Valves.

3.2.04.01 Lift Check Valves. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.

3.2.04.02 Swing Check Valves. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.

3.2.05 Eccentric Plug Valves. Eccentric plug valves shall be installed with the shaft horizontal and the plug in the upper half of the valve body. Valves in wastewater, sludge, or scum lines shall be installed with the seat on the upstream end.

3.2.06 Resilient Seated Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendix to ANSI/AWWA C509 and with the recommendations of the manufacturer.

3.2.07 Double Disc Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendix to AWWA C500 and with the recommendations of the manufacturer.

3.2.08 Air Release and Combination Air Valves. The exhaust from each valve shall be piped to a suitable point acceptable to Engineer. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches (150 mm) above the floor.

3.2.09 Valve Boxes. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3.2.10 Yard Hydrants. A concrete slab 18 inches (450 mm) square and 4 inches (100 mm) thick shall be provided around the top of each 3/4 inch (19 mm) and 1-1/2 inch (38 mm) yard hydrant. Hydrants shall be installed plumb. Hydrant drainage shall be provided by installing below each hydrant at least 1 cubic foot (0.03 m^3) of gravel or crushed stone.

Each 4 inch (100 mm) yard hydrant shall be set on a concrete foundation at least 18 inches (450 mm) square and 6 inches (150 mm) thick. Each hydrant shall be anchored in place or adequately blocked to prevent the hydrant from blowing off the supply connection. Hydrant drainage shall be provided by installing at least 7 cu. ft (0.20 m^3) of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.

An operating wrench shall be provided for each yard hydrant.

3.3 VALVE ACTUATORS. Valve actuators and accessories will be furnished by others and shall be installed in accordance with the equipment manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. After installation, all valves 12” and above shall be tested in conjunction with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.4.01.01 Pressure Tests. Pressure testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.4.01.02 Leakage Tests. All valves shall be free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor. Leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.5 ADJUSTING. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic and electric actuated valve.

End of Section

SECTION 15020

MISCELLANEOUS PIPING AND ACCESSORIES INSTALLATION

PART 1 - GENERAL

1.1 SCOPE. This section covers the installation of miscellaneous piping, cast iron soil pipe, copper tubing, and accessories as indicated on the drawings. Contractor shall furnish all necessary jointing materials, coatings, and accessories that are specified herein.

Pipe supports and anchors shall be furnished by Contractor, and are covered in Master Specification Section 15140, Pipe Supports. Pipe trenching and backfilling are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

1.2 GENERAL.

1.2.01 Coordination. Materials installed under this section shall be installed in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by Engineer.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Chlorine tank car unloading connection.

Cleaning procedure for metal chlorine piping.

Watertight/dusttight pipe sleeves.

1.3.02 Welder Certification. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified. Copy of certification and identification stamp shall be submitted for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by Engineer.

1.3.03 Spool Drawings. Spool drawings indicating the complete line, showing all welded and assembly items, except for insulation shoes or nonstress-relieved lines shall be developed and submitted.

1.4 QUALITY ASSURANCE.

1.4.01 Welding and Brazing Qualifications. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.4.02 Tolerances. These tolerances apply to in-line items and connections for other lines.

The general dimension, such as face-to-face, face on end-to-end, face- or end-to center and center-to-center shall be 1/8 inch [3 mm].

The inclination of flange face from true in any direction shall be 3/64 inch per foot [4 mm per meter].

Rotation of flange bolt holes shall not exceed 1/16 inch [1.5 mm].

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Plastic pipe, tubing, and fittings shall be stored between 40°F and 90°F (4°C and 32°C).

1.5.01 Coated Pipe. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic-coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Pipe, tubing, and fittings covered herein shall be installed in the services indicatedin the Contract Documents.

2.2 MATERIALS.

Solder	Solid wire, ASTM B32, Alloy Grade Sb5, (95-5).
Soldering Flux	Paste type, Fed Spec O-F-506, Type I, Form A.
Brazing Filler Metal	AWS A5.8, BCuP-5; Engelhard "Silvaloy 15", Goldsmith "GB-15", or Handy & Harman "Sil-Fos".
Brazing Flux	Paste type, Fed Spec O-F-499, Type B.
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Pipe Insulation	See Section 15250.
Watertight/Dusttight Pipe Sleeves	O-Z Electrical Manufacturing "Thruwall" and "Floor Seals", or Thunderline "Link-Seals"; with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts.
Pipe Sleeve Sealant	Polysulfide or urethane, as specified in the caulking section.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Never-Seez "Pure Nickel Special", or Permatex "Nickel Anti-Seize".
Teflon Thread Sealer	Paste type; Hercules "Real-tuff", John Crane "JC-30", or Permatex "Thread Sealant with Teflon".

Teflon Thread Tape	Hercules "Tape Dope" or John Crane "Thred-Tape".
Solvent Cement	
PVC Systems	ASTM D2564.
CPVC Systems	ASTM F493.
Sodium Hypochlorite, Sodium Hydroxide, and Sodium Bisulfite Service	IPS Corporation "Weld-On 724"
Primer	ASTM F656.
Protective Coatings	
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils [760 µm]; Protecto Wrap "200" or Tapecoat "CT".
Primer	As recommended by the tape manufacturer.
Medium Consistency Coal Tar	Carboline "Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol".
Chlorine Tank Car Unloading Connection	Special flanged hose assembly conforming to materials and details on Drawing No. 135, The Chlorine Institute, Inc.

PART 3 - EXECUTION

3.1 INSPECTION. All piping components shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 PREPARATION.

3.2.01 Field Measurement. Pipe shall be cut to measurements taken at the site, not from the drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION.

3.3.01 General. All instruments and specialty items shall be installed in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and with sufficient clearance and access for ease of operation and maintenance.

Flat faced wrenches and vises shall be used for copper tubing systems. Pipe wrenches and vises with toothed jaws will damage copper materials and shall not be used. Bends in soft temper tubing shall be shaped with bending tools.

3.3.02 Pipe Sleeves. Piping passing through concrete or masonry shall be installed through sleeves that have been installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors with a special finish, such as ceramic or vinyl composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. Unless otherwise indicated on the drawings, in all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch (25 mm) nor more than 2 inches [50 mm] above the floor surface, with the projections uniform within each area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the drawings indicate future installation of pipe, sleeves fitted with suitable plastic caps or plugs shall be provided.

Holes drilled with a suitable rotary drill will be considered instead of sleeves for piping which passes through interior walls and through floors with a special finish.

Unless otherwise indicated on the drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements.

Piping passing through locations shall be made dusttight and gastight with special rubber-gasketed sleeve and joint assemblies; with sleeves sealed with modular rubber sealing elements; or by caulking with oakum and polysulfide or urethane sealant.

3.3.03 Pipe Joints. Pipe joints shall be carefully and neatly made in accordance with the indicated requirements.

3.3.03.01 Threaded. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs.

Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads.

Threaded joints in steel piping for chlorine service shall be made up with teflon thread tape or litharge and glycerine paste applied to all male threads.

Threaded joints for diesel fuel oil and fuel oil piping shall be seal welded.

At the option of Contractor, threaded joints in other piping may be made up with teflon thread tape, thread sealer, or a suitable joint compound.

Seal welds shall cover all exposed threads. Thread tape and joint compound or sealers shall not be used in threaded joints which are to be seal welded. Seal welding of threaded joints that have failed a pressure test shall not be made until all thread compound and teflon tape have been removed.

3.3.03.02 Compression. Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past fingertight, or as recommended by the fitting manufacturer, to produce a leaktight, torque-free connection.

3.3.03.03 Flared. Ends of annealed copper tubing shall be cut square, and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as needed to produce leaktight connections.

3.3.03.04 Soldered and Brazed. Where solder fittings are specified for lines smaller than 2 inches [50 mm], joints may be soldered or brazed at the option of Contractor. Joints in 2 inch [50 mm] and larger copper tubing shall be brazed. Joints in copper chlorine tubing and refrigerant piping shall be brazed; solder will not be acceptable. Brazing alloy shall contain no tin.

Surfaces to be joined shall be thoroughly cleaned with flint paper and coated with a thin film of flux. At each joint, tubing shall enter to the full depth of the fitting socket.

Care shall be taken to avoid overheating the metal or flux. Each joint shall be uniformly heated to the extent that filler metal will melt on contact. While the joint is still hot, surplus filler metal and flux shall be removed with a rag or brush.

3.3.03.05 Solvent Welded. Solvent welded connections shall only be used for PVC or CPVC pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing time, as set forth in Table X2.1 of ASTM D2855, has elapsed.

3.3.03.06 Epoxy and Adhesive Bonded. Epoxy and adhesive bonded joints shall only be used for FRP pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. After joining, either the pipe or the fitting shall be rotated approximately one-half turn to uniformly distribute adhesive. A slight fillet of adhesive at the bond line is desirable, but all excess adhesive shall be wiped off immediately. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the curing period recommended by the manufacturer.

3.3.03.07 Heat Fusion Bonded Joints. All joint preparation, cutting, jointing equipment, and jointing procedures shall comply with the pipe manufacturer's recommendations. The heating time, temperature, pressure applied to the joint during bonding, and cooling time shall consistently produce leaktight joints as strong as the pipe being joined.

3.3.03.08 Flanged. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but shall not be torqued less than the minimum value required by the gasket manufacturer. Flange bolts shall not be so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.

Flange bolt holes shall be oriented as follows, unless otherwise indicated on the spool drawings:

Vertical flange face:	Bolt holes to straddle the vertical centerlines.
Horizontal flange face:	Bolt holes to straddle plant north-south centerlines.

Pipe sealants, thread compounds, or other coatings shall not be applied to flange gaskets unless recommended by the gasket manufacturer for the specified service and approved by Engineer.

Welds at orifice flanges shall have internal surfaces ground smooth to the pipe wall.

Slip-on flanges shall be welded inside and outside. There shall be a distance of approximately 1/16 to 1/8 inch [1.5 to 3 mm] between the edge of the fillet weld and the face of the flange. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.

Flat-faced flanges shall be used when mating to Class 125 flanges. Full-face gaskets shall be used with flat-faced flanges and ring gaskets shall be used with raised faced flanges.

Weld neck flanges shall be used with butt-weld fittings. The bore of weld neck flanges shall match the pipe wall thickness.

Insulating joints connecting submerged (buried) piping to exposed piping shall be installed above the maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged (buried) metallic piping shall be isolated from the concrete reinforcement. Insulating flanges shall be tested for electrical isolation after installation and bolt-up but prior to introduction of conducting fluid.

3.3.03.09 <u>Welded</u>. Welding shall conform to the specifications and recommendations contained in the ANSI B31.1 Code for Pressure Piping.

Weld cross-sections shall be equal to or greater than the pipe wall thickness. Welds shall be smooth and continuous and shall have interior projections no greater than 1/16-inch [1.5 mm]. Backing strips or rings shall not be used except with specific prior review by Engineer as to use, material, and design. Root gap inserts that are completely melted and consumed in the weld bead are acceptable only when reviewed in advance by Engineer.

Stainless steel welding shall be inert gas tungsten arc (TIG) or the direct current, straight polarity, inert gas metal arc process (MIG).

Carbon steel welding shall be made by the shielded metal arc process.

3.3.03.10 <u>Grooved Couplings</u>. Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions, as set forth in AWWA C606, and shall be clean and sharp without burrs or check marks.

3.3.03.11 <u>Push-on</u>. Gasket installation and other jointing procedures shall be in accordance with the recommendations of the manufacturer. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

3.3.03.12 Rubber-Gasketed. Rubber-gasketed joints for hub and spigot type cast iron soil pipe shall have plain spigot ends, without beads. Cut ends of all pipe shall be cut square, beveled, and all burrs shall be removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

3.3.03.13 Other Pipe Joints. Coupled joints in tempered glass pipe, plastic joints in vitrified clay pipe, and other proprietary type joints shall be made in accordance with the manufacturer's recommendations and to the satisfaction of Engineer.

3.3.04 Pipe. Pipe shall be installed as specified, as indicated on the drawings, or, in the absence of detail piping arrangement, in a manner acceptable to Engineer.

Piping shall be installed without springing or forcing the pipe in a manner which would induce stresses in the pipe, valves, or connecting equipment.

Piping shall be supported in conformance with Master Specification Section 15140, Pipe Supports.

Piping shall be connected to equipment by flanges or unions as specified in the pipe procurement sections. Piping connecting to equipment shall be supported by a pipe support and not by the equipment.

Water, gas, and air supply piping shall be provided with a shutoff valve and union at each fixture or unit of equipment, whether or not indicated on the drawings, to permit isolation and disconnection of each item without disturbing the remainder of the system. Air supply piping shall be provided with sectionalizing valves and valved air inlet connections as needed for isolation of portions of the system for periodic testing. Gas supply lines to buildings shall be provided with a shutoff valve and union located above grade immediately outside the building. A capped drip leg shall be provided at the bottom of the vertical riser of gas supply piping adjacent to gas-fired appliances.

A union shall be provided within 2 feet [600 mm] of each threaded-end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping adjacent to devices or equipment which may require removal in the future and where required by the drawings or the specifications.

All air piping shall be graded to points of drainage collection where drip legs and drain valves shall be provided. Air piping shall be sized for the service conditions, with the indicated minimum sizes:

Service	Minimum Size
Air signal	1/4 inch OD [6 mm OD]
Power air	1/2 inch OD [13 mm OD]
Air supply	1/2 inch OD [13 mm OD]
Bubbler drop pipes	3/4 inch [19 mm]
Buried piping	3/4 inch [19 mm]

Water supply piping within structures shall be arranged, and facilities provided, for complete drainage. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.

All digester gas piping shall be graded to points of drainage collection where drip legs and drip traps shall be provided.

Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.

Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a ball type shutoff valve.

Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

In all piping except air and gas piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

Buried PVC piping shall be "snaked" in the trench and shall be kept as cool as possible during installation. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation.

All chemical piping shall be installed so that lines are readily accessible for cleaning. Tees shall be provided at regular intervals in all chemical piping except chlorine piping, with extra openings plugged, to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of the plugs so that they can be easily removed. At each point where hose or reinforced plastic tubing is connected to rigid piping, a quick-disconnect coupling shall be provided.

Anhydrous ammonia, chlorine and sulfur dioxide gas and vent piping shall be installed so that liquid traps are avoided. The open end of each vent line shall elbow down and shall be provided with a corrosion-resistant insect screen.

Double-contained chemical feed piping shall be installed according to the manufacturer's recommendations. Joints shall be solvent cemented. Splitting and rewelding of fittings will not be acceptable. Suitable drains and vents shall be provided to permit complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be designed to allow continuous drainage in the annular space to the drain ports. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment can be readily drained and manually inspected for leaks.

Polyethylene piping shall be installed in accordance with the manufacturer's recommendations. A continuous 12 AWG THHN insulated copper tracer wire shall be placed 6 inches (150 mm) above all portions of the buried pipe, but no more than 18 inches (450 mm) below the ground surface. Where the pipe extends above grade, a 2 foot (0.6 m) length of wire shall be coiled and attached to the pipe.

Piping adjacent to flow sensors shall be installed in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices of the appropriate straight pipe runs both upstream and downstream.

Drains required for operation are shown on the drawings. However, vents at all high points and drains at all low points in the piping that are required for complete draining for pressure test may not be shown on these drawings. Contractor shall add such items as found to be necessary during detail piping design and/or piping installation.

3.3.05 Reducers. Eccentric reducers shall be installed flat on the bottom for steam, condensate return and digester gas services.

3.3.06 Valves. Prior to soldering or brazing valves, teflon and elastomer seats and seals shall be removed to prevent damage.

Isolation valves provided with equipment and instruments shall be located in a manner which will allow ease of access and removal of the items to be isolated.

3.4 PIPING ASSEMBLY.

3.4.01 General. Contractor shall employ only labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner.

Contractor shall designate a quality assurance inspector who is acceptable to the Owner to inspect the installation, cleaning, and testing of the piping systems. The inspector shall also be responsible to maintain records for all spools and appurtenances for inspection and approval by the Owner's designated representative.

The specification and qualification of weld joints and welders shall be in accordance with ASME Boiler Pressure Vessel Code, Section IX, Welding and Brazing.

Weld procedure specifications (WPS) and procedure qualification reports (PQR) shall be submitted to Engineer for review and validation of joint design, efficiencies and strength before fabrication begins.

The supervision of quality control and quality assurance programs for shop-fabricated piping and skid-mounted equipment for both direct and sub-contracted work shall be by Contractor.

Inspection techniques and acceptance criteria shall be in accordance with Section VI, Inspection, Examination, and Testing of the Piping Codes and ASME Boiler and Pressure Vessel Code Section V, Nondestructive Examination.

Contractor shall have a quality control/quality assurance program to do the following minimum level of nondestructive examination (NDE) for steam and condensate systems:

100 percent visual examination of welds by a qualified examiner (per B31.1).

20 percent random sampling for material's compliance with fitting, pipe, valves and flange requirements. Materials are considered acceptable if the examiner can visually identify foundry markings or mill marking and the ASTM markings comply with engineering specifications.

10 percent of the flanges will be torqued with a calibrated torque wrench. Acceptance criteria for bolt torque will be identified in the QC Program Manual. Bolts and nuts will be checked for foundry markings and compared to the Specifications.

100 percent of the piping supports that use guides, anchors, spring hangers, and stops will be examined.

Contractor shall have a quality control/quality assurance program to do the following minimum level of nondestructive examination (NDE) for all other systems:

5 percent random sampling of 100 percent radiographic testing (RT) or ultrasonic testing (UT) or in-process visual weld examination.

15 percent random sampling for material's compliance with fitting, pipe, valve and flange requirements. Materials are considered acceptable if the examiner can visually identify the foundry markings or mill marking and the ASTM markings comply with engineering specifications.

10 percent of the flanges will be torqued with a calibrated torque wrench. Bolts and nuts will be checked for foundry markings and compared to the Specifications.

100 percent of the piping supports that use guides, anchors and stops will be examined.

If Contractor has developed alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, a proposal on such techniques or methods shall be submitted in writing to Engineer for review and approval at least 14 days before intended date of use.

If there is a conflict between the mechanical drawings and piping and instrumentation drawings (P&IDs), the P&ID shall take precedence.

Any deviations from the Specifications and piping locations shown on the Drawings require prior review and approval by Engineer.

Welding shall not begin until weld joint and welder qualification submittals have been reviewed and approved.

3.5 PROTECTIVE COATING. Standard weight black steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating.

Extra strong black steel pipe in buried locations shall have exterior surfaces protected as specified herein.

The exterior surfaces of all fittings, couplings, specials, and other portions of buried piping not protected with plastic coating shall be tape-wrapped in the field. All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils [1.5 mm]. Joints in plastic-coated pipe shall be cleaned, primed, and tape-wrapped after installation.

Joints in galvanized steel piping in underground locations shall be field painted with two coats of coal tar coating.

3.5.01 Inspection. All shop-applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field-applied tape wrap on pipe, joints, fittings, and valves shall be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings after installation of the pipe or fitting in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged during installation. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.

The inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.4 of ANSI/AWWA C209.

3.6 PRESSURE AND LEAKAGE TESTING. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. Piping shall be tested at the indicated pressures:

Service	Test Pressure	Test Medium
Water supply	1-1/2 times working pressure but not less than 120 psi [828 kPa]	Water
Gas supply	1-1/2 times working pressure but not less than 60 psi [414 kPa]	Compressed air
Air supply and signal	1-1/2 times working pressure but not less than 50 psi [345 kPa]	Zero humidity air or nitrogen
Liquid chlorine and anhydrous ammonia, chlorine and sulfur dioxide gas pressure piping	300 psi [2068 kPa]	Zero humidity air or nitrogen
Chlorine and sulfur dioxide gas	15 inches [51 kPa] of mercury vacuum	Atmospheric air

vacuum piping		
Other piping	1-1/2 times working pressure but not less than 50 psi [345 kPa]	Suitable fluid or gas; for distilled water piping, distilled water or filtered oil-free compressed air may be used

Compressed air or pressurized gas shall not be used for testing plastic piping unless specifically recommended by the pipe manufacturer.

Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped as needed during the testing.

After completion of the specified pressure tests, all anhydrous ammonia, chlorine and sulfur dioxide gas piping shall be tested for leakage using the appropriate gas chemical at operating pressures. Piping shall be thoroughly cleaned and dried before admitting gas chemical into the system. Gas chemical shall be slowly admitted to the piping system.

For chlorine gas piping, leakage shall be checked by waving a swab soaked in aqua ammonia solution near each fitting. Ammonia solution shall not be applied directly to the fittings. Formation of white fumes will indicate the presence of leaks. All chlorine gas shall be purged from the line before leaks are repaired.

Unless otherwise required by the applicable codes, drainage and venting systems shall be water or air tested, as required. For water testing, the drainage and venting system shall be filled with water to the level of the highest vent stack. For air testing, the system shall be charged with air to a minimum pressure of 5 psig [35 kPa]. Openings shall be plugged as necessary for either type of test. To be considered free of leaks, the system shall hold the water or air for 30 minutes without any drop in the water level or air pressure.

All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor and at the time directed by Engineer.

All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

3.6 CLEANING. The interior of all pipe, valves, and fittings shall be smooth, clean, and free of blisters, loose mill scale, sand, dirt, and other foreign matter when installed. Before being placed in service, the interior of all lines shall be thoroughly cleaned, to the satisfaction of Engineer.

Metal anhydrous ammonia, chlorine and sulfur dioxide piping shall be cleaned as recommended by the gas chemical feed system supplier. All surfaces which may come into contact with gas chemical shall be thoroughly dry and free of oil or grease before being placed in service. The recommended cleaning procedures shall be submitted for review in accordance with Master Specification Section 01080, Project Submittals.

Tin-lined copper tubing for distribution of distilled water shall be flushed and cleaned with distilled water in accordance with the tubing manufacturer's recommendations.

3.7 ACCEPTANCE. Owner reserves the right to have any section of the piping system which he suspects may be faulty cut out of the system by Contractor for inspection and testing. Should the joint prove to be sound, Owner will reimburse Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test will continue joint by joint in all directions until sound joints are found. Costs for replacement of faulty work and/or materials shall be the responsibility of Contractor.

End of Section

SECTION 15060

MISCELLANEOUS PIPING AND PIPE ASSEMBLIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous piping and pipe assemblies for the services as indicated in the Contract Documents. This section includes the following types of pipe:

Regular Weight Brass Pipe
Extra Strong Brass Pipe
Polyethylene Hose
Tempered Glass Pipe
Nickel Alloy Pipe

Miscellaneous piping shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but shall not be limited to, the following:

Chemical resistant waste pipe and fittings.

Hose couplings.

Name of Manufacturer

Type and model

Construction materials, thickness, and finishes,

Pressure and temperature ratings

1.3 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Miscellaneous piping materials shall be as indicated.

Material Classification	BR-1
Regular Weight Brass Pipe	
Pipe	ASTM B43, red brass, seamless, regular weight.
Fittings	ANSI/ASME B16.15, Class 125.
Material Classification	BR-2
Extra Strong Brass Pipe	
Pipe	ASTM B43, red brass, seamless, extra strong.
Fittings	ANSI/ASME B16.15, Class 125.
Material Classification	HS-1
Hose With Insert Type Couplings	
Hose	ID not smaller than nominal size.
	Boston " Crosslinked Polyethylene Hose" or Gates "Renegade", "Mustang 45 HW" or "Stallion" acid-chemical hose. To be selected for resistance to the service chemical.
Couplings	Rigid PVC or other material suitable for service conditions, with band type stainless steel clamps.
Material Classification	HS-2
Hose With Quick Disconnect Couplings	

Hose	ID not smaller than nominal size. Boston " Crosslinked Polyethylene Hose" or Gates "Renegade", "Mustang 45 HW" or "Stallion" acid-chemical hose. To be selected for resistance to the service chemical.
Couplings	OPW "Quick Coupler" or PT Coupling "Quick Connect/Disconnect Coupling"; polypropylene or other material suitable for service conditions.
Material Classification	TG-1
Tempered Glass Pipe	
Pipe	Borosilicate glass, ASTM C 1053. Schott "Kimax", or equal.
Fittings	Borosilicate glass, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard drainline coupling with compression liner, seal ring, and stainless steel band and bolt. Joints shall be "bead-to-bead" or "bead-to-plain end" type.
Material Classification	CRP-1
Carpenter 20-Cb3	
Welded	ASTM B464 - UNS NO8020.
Seamless	ASTM B729 - UNS NO8020.
Fittings	ASTM B462 - UNS NO8020. The use of flanged fittings shall be limited to equipment connections.

2.1.02 Accessories. Accessories for miscellaneous piping systems shall be as indicated.

Unions For Brass pipe	Fed Spec WW-U-516, Class 125.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15061

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of ductile iron pipe, except ductile iron pipe used for buried water main service. Ductile iron pipe shall be furnished complete with all fittings, jointing materials, pipe hangers and supports, anchors, blocking, encasement, and other appurtenances.

Piping furnished hereunder shall be complete with all joint gaskets, bolts, and nuts required for installation of any valves and equipment furnished by others for installation under this contract.

Pipe hangers and supports are covered in Master Specification Section 15140, Pipe Supports. Pressure and leakage testing is covered in Master Specification Section 15020, Miscellaneous Piping and Accessories Installation. Cleaning and disinfection are covered in Master Specification Section 02675, Disinfection of Water Distribution System. Cast iron soil pipe is covered in Master Specification Section 15069, Cast Iron Soil Pipe and Accessories.

Ductlie iron pipe for buried water main service is covered in Master Specification Section 02620, Water Main Services and Gate Valves. Pipe trenching, bedding, and backfill are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

1.1.02 Pipe Manufacturer’s Experience and Field Services. All ductile iron pipe, fittings, and specials shall be fabricated, lined, and coated by the pipe manufacturer. Minimum required experience qualifications shall include manufacture of a pipeline at least 1 mile (1.6 km) in length, of equal or larger diameter than the pipe to be provided, with joints, lining, and coating suitable for the same or greater pressure rating, which has performed satisfactorily for the past 5 years.

An experienced, competent, and authorized field service representative shall be provided by the pipe manufacturer to perform all pipe manufacturer’s field services specified herein. The field service representative's minimum required experience qualifications shall include 5 years of practical knowledge and experience installing ductile iron pipe with joints, lining, and coating of the pipe to be provided. The pipe manufacturer’s field service representative shall be acceptable to Owner. A resume of the proposed pipe manufacturer’s field service representative shall be submitted for review. The resume shall include the field service representative’s experience record which meets the specified minimum required experience qualifications.

All ductile iron pipe shall be installed in accordance with the pipe manufacturer's recommendations. The pipe manufacturer's field service representative shall visit the site and inspect, check, instruct, guide, and direct Contractor's procedures for pipe handling, laying, and jointing at the start of pipe installation for each crew. The pipe manufacturer's field service representative shall coordinate his services with Contractor.

Each joint, including restrained joints, shall be checked by Contractor as instructed by the pipe manufacturer's field service representative to determine that the joint and the restraints are installed properly.

The pipe manufacturer's field service representative shall furnish to Owner, through Engineer, a written report certifying that Contractor's installation personnel have been properly instructed and have demonstrated the proper pipe handling and installation procedures. The pipe manufacturer's field service representative shall also furnish to Owner, through Engineer, a written report of each site visit.

All costs for these services shall be included in the Contract Price.

1.1.03 Emergency Repair Manual. Contractor shall submit an emergency repair manual prepared and furnished by the pipe manufacturer. The emergency repair manual shall include procedures for handling emergency calls and repairs; a list of stock replacement pipe sections, closures, and other parts needed for emergency repairs; names and emergency telephone numbers of pipe manufacturer's engineering staff and factory-trained field service representatives who can be contacted day or night during an emergency; response and delivery times; and installation instructions for the materials and methods used in making repairs. The pipe manufacturer shall provide emergency assistance that may be required, during the construction and warranty period, at no additional cost to Owner.

1.2 SUBMITTALS. Drawings, details, specifications, and installation schedules covering all ductile iron pipe and accessories shall be submitted in accordance with the procedure set forth in Master Specification Section 01080, Project Submittals. The drawings and data shall include, but shall not be limited to, the following:

Certification by manufacturer for each item furnished in accordance with the ANSI/AWWA Standards.

Certification of gaskets.

Certification of proof-of-design tests for joints.

Certification of proof-of-design tests for welded-on outlets.

Laying schedule complete with an explanation of all abbreviations used in the schedule.

Two samples of the polyethylene encasement, each sample clearly indicating all identification required by the Governing Standard.

Submittal data shall clearly indicate the country of origin of pipe, fittings, restraining devices, and accessories. Certified copies of physical and chemical test results as outlined in AWWA C151 shall be submitted for the materials to be provided.

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining when it is specified.

Contractor furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.

If the lining of Owner furnished pipe or fittings is damaged by Contractor during unloading or handling, the damaged pipe or fittings shall be replaced by and at the expense of Contractor. Where the damaged areas are small and readily accessible, Contractor may be permitted to repair the lining.

Contractor shall repair any damage to pipe coatings before the pipe is installed.

PART 2 - PRODUCTS

2.1 PIPE CLASS. The class of ductile iron pipe shall be as indicated in the Ductile Iron Pipe Schedule 15061-S01 or as indicated in the Contract Documents. The specified class includes corrosion allowance and casting allowance.

Pipe wall thickness for grooved and threaded pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size		Minimum Class	
Inches	mm	Threaded Ends (1)	Grooved Ends (2)
4-16	100-400	53	53
18	450	53	54
20	500	53	55
24	600	53	56
30-54	750-1400	53	--
60 & 64	1500-1600	350	--

(1) Complies with ANSI/AWWA C115/A21.15 for minimum pipe wall thickness for threaded flanges.

(2) Grooved couplings are cataloged through 24 inch (600 mm); larger sizes require cast-on or threaded-on shoulders.

2.2 MATERIALS. All materials in contact with potable water shall have NSF 61 certification.

Pipe	Ductile iron, ANSI/AWWA C151/A21.51, Table 1 or Table 3.
Gaskets – All Joint Types	Gaskets shall be synthetic rubber. Natural rubber will not be acceptable. For potable water service, gaskets shall be certified as suitable for chlorinated and chloraminated potable water; a certificate of gasket suitability shall be submitted.
Fittings	Ductile iron, ANSI/AWWA C110/A21.1 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the drawings.

Fitting Size in (mm)	Material	Type	Min. Working Pressure Rating, psi (kPa)
4 to 24 (100 to 600)	DI	Mechanical and Push-on joints	350 (2400)
4 to 24 (100 to 600)	DI	Flanged joints	250 (1700)
30 to 48 (750 to 1200)	DI	All joints	250 (1700)
54 to 64 (1350 to 1600)	DI	All joints	150 (1000)

All fittings shall be ductile iron and suitable for a test pressure of 1.5 times rated working pressure without leakage or damage.

Push-on Joints	ANSI/AWWA C111/A21.11.
Restrained Push-on Joints, gaskets with stainless steel gripping segments, as required (4 inch through 12 inch) (100 mm through 300 mm).	US.Pipe "Field Lok Gasket", or American "Fast Grip".
Restrained Push-on Joints, locking wedge type, as required (4 inch through 20 inch) (100 mm through 500 mm).	EBAA Iron "Megalug" Series 1700, without exception.
Restrained Push-on Joints, positive locking segments and/or rings, as required (4 inch through 64 inch) (100 mm through 1600 mm).	American "Flex-Ring," or "Lok-Ring"; Clow "Super-Lock"; U.S. Pipe "TR Flex"; or Griffin "Snap-Lok".
Flanged Joints	ANSI/AWWA C115/A21.5.
Flanges	
Class 250	Ductile iron, flat faced, with ANSI/ASME B16.1, Class 250 diameter and drilling.

All Others	Ductile iron, ANSI/AWWA C115/A21.15.
Flanges	All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.
Bolts	ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch (6.3 to 12.7 mm) beyond outer face of nut.
Nuts	ASTM A307, hexagonal, ANSI/ASME B18.2.2, heavy semi-finished pattern.
Gaskets	ASTM D1330, Grade I rubber, full face type, 1/8 inch (3 mm) thick.
Insulated Flanges	
Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.
Insulation Kits	As manufactured by Central Plastics or PSI Industries.
Insulating Gaskets	Type E, pyrox 1E glass reinforced epoxy, 1/8 inch (3 mm) thick, with Buna-N sealing element.
Bolt Insulating Sleeves	Mylar, 1/32 inch (0.79 mm) thick.
Insulating Washers	Phenolic laminate, 1/8 inch (3 mm) thick, one for each flange bolt.
Backing Washers	Steel, 1/8 inch (3 mm) thick, two for each flange bolt.
Mechanical Joints	ANSI/AWWA C111/A21.11.
Restrained Mechanical Joints (Factory prepared spigot), as required (4 inch through 48 inch) (100 mm through 1200 mm).	American "MJ coupled Joints", or Griffin "Mech-Lok".

Restrained Mechanical Joints, (field cut spigot), as required (4 inch through 20 inch) (100 mm through 500 mm).	EBAA Iron "Megalug" Series 1100, without exception.
Wall Castings	Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron. All holes shall be sized in accordance with the details on the drawings and shall be provided with removable plugs.
Mechanical Joints with Tie Rods	See standard details.
Tie Rods	ASTM A307.
Steel Pipe	ASTM A53, standard weight.
Washers	ANSI B18.22.1, plain steel.
Threaded Connections	ANSI/ASME B1.20.1, NPT; provide boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.
Mechanical Couplings	
Couplings	Dresser "Style 38," Smith-Blair "441 or 411 Flexible Coupling," or Romac "Style 501"; without pipe stop.
Gaskets	Oil-resistant synthetic rubber.
Grooved Couplings	AWWA C606.
Pipe Ends (rigid joints), as required.	Grooved, with dimensions conforming to AWWA C606, Table 3.
Pipe Ends (flexible joints), as required	Shouldered, with dimensions conforming to AWWA C606, Table 4.

Couplings (non-shouldered pipe)	Grinnell "Figure 7001," or Victaulic "Style 31."
Couplings (shouldered pipe)	Victaulic "Style 41" or "Style 44".
Flanged Coupling Adapters	Smith-Blair "Type 912" or Romac "Style FCA501", with anchor studs for 12 inches (300 mm) and smaller, as required; Smith-Blair "Type 913" or Romac "Style FC400", 14 inches (350 mm) and larger.
Tapping Saddles	Ductile iron, with steel straps and rubber sealing gasket, 250 psi (1700 kPa)) pressure rating.
Shop Coating and Lining	
Cement Mortar Lining	ANSI/AWWA C104/A21.4.
Polyethylene Lining	ASTM D1248, Class C, heat bonded, 40 mil (1000 µm) nominal thickness, except min thickness shall be at least 30 mils (750 µm). Thickness may taper to not less than 10 mils (250 µm))beginning 4 inches (100 mm) from the end of pipe or fitting.
Ceramic Epoxy Lining	Induron "Protecto 401 Ceramic Epoxy".
Calcium Aluminate Lining	La Farge "SewperCoat".
Glass Lining	Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 8 mils (200 µm), Mohs' Hardness 5 to 6 density (2500 to 3000 kg/m^3) as determined by ASTM D792; Ceramic Coating "Non-Stick Glass Lining" or Victo "SG-14 Glass Lined Pipe."
Universal Primer	Manufacturer's standard.
Asphaltic Coating	Manufacturer's standard.
Coal Tar Epoxy	Manufacturer's standard.

Liquid Epoxy	ANSI/AWWA C210.
Medium Consistency Coal Tar	Carboline "Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol."
Polyethylene Encasement	Seamless, ANSI/AWWA C105/A21.5; LLD-8 mil (200 μm) or HDCL-4 mil (100 μm).

2.3 SHOP COATING AND LINING. The interior of all pipe and fittings for water or water treatment service shall be cement mortar lined. The interior of all pipe for gravity sewers shall be lined with the material as specified herein. The interior of all pipe for other services, except air, shall be cement mortar lined. The interior of all air piping shall be unlined and uncoated.

Glass-lined pipe or other lining, as specified, shall be provided for the following wastewater facilities services:

Scum piping.

All sludge piping except piping conveying activated sludge from final settling basins.

Sludge holding tank overflow piping.

Sludge holding tank supernatant drawoff piping.

Where buried or embedded in concrete, glass-lined pipe shall be ductile iron with mechanical or push-on joints; glass-lined pipe installed in interior locations may be flanged ductile iron with flanged cast or ductile iron fittings.

The exterior surfaces of all pipe and fittings which will be exposed in interior locations shall be shop primed. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

PART 3 - EXECUTION

3.1 INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; spigot ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site of the work.

3.2 PREPARATION. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter prior to installation. Before jointing, all joint contact surfaces shall be wire brushed if necessary, wiped clean, and kept clean until jointing is completed.

Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

3.3 CUTTING PIPE. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

All field cutting of existing gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.

Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be permitted. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be permitted.

3.4 ALIGNMENT. Piping shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Deflections form a straight line or grade shall not exceed the values stipulated in Table 4 or Table 5 of AWWA C600, unless specially designed bells and spigots are provided.

Either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the drawings.

Batter boards, laser beam equipment, or surveying instruments shall be used to maintain alignment and grade.

If batter boards are used to determine and check pipe subgrades, they shall be erected at intervals of not more than 25 feet (8 m). At least three batter boards shall always be maintained in proper position when trench grading is in progress.

If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.5 LAYING PIPE. Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions.

Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water from entering the pipe.

Pipe shall be laid with the bell ends facing the direction of laying, except when reverse laying is specifically authorized by Engineer.

3.6 FIELD JOINTS. Joints in buried locations shall be mechanical or push-on type unless otherwise indicated on the drawings. Bells on wall castings and wall sleeves shall be mechanical joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the drawings.

Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11-90, Section 4.5, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2 times the working pressure or 1-1/2 times the test pressure of the pipeline, whichever is higher. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design.

Where acceptable to Engineer, as required, grooved couplings may be used instead of flanges, provided that rigid grooving is used to preclude longitudinal pipe movement and angular deflection at joints. Fittings, valves, and equipment installed using grooved couplings shall be adequately supported and blocked or restrained to prevent rotation.

3.7 MECHANICAL JOINTS. Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Overtightening of bolts to compensate for poor installation practice will not be permitted.

The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top (or side for vertical piping) center line. The top (or side) center line shall be marked on each flange and mechanical joint piece at the foundry.

3.8 <u>PUSH-ON JOINTS</u>. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

3.9 <u>FLANGED JOINTS</u>. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe center line.

When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually and at a uniform rate, to ensure uniform compression of the gasket.

Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before any bolts are installed in the flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position, which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.

3.10 <u>FLANGED COUPLING ADAPTERS</u>. Flanged coupling adapters shall be installed in strict accordance with the coupling manufacturer's recommendations. After the pipe is in place and bolted tight, the proper locations of holes for the anchor studs shall be determined and the pipe shall be field-drilled. Holes for anchor studs shall be drilled completely through the pipe wall. Hole diameter shall be not more than 1/8 inch (3 mm) larger than the diameter of the stud projection.

The inner surfaces of couplings shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except flange mating surfaces, shall be cleaned and shop primed with universal primer.

3.11 MECHANICAL COUPLINGS. Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations. A space of at least 1/4 inch (6 mm), but not more than 1 inch (25 mm), shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

The interior surfaces of the middle rings shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining components shall be cleaned and shop primed with universal primer.

3.12 GROOVED END JOINTS. Grooved couplings with rigid type grooving shall be installed in accordance with the coupling manufacturer's recommendations. Completed joints shall be rigid and shall not allow angular deflection or longitudinal movement. Except for closure pieces, field grooving of pipe will not be permitted.

Special care shall be taken when connecting to pumping equipment to avoid transmitting pipe stresses to the pump flanges. Piping shall be permanently supported to obtain accurate matching of piping and abutting pump flanges before bolts are installed in the flanges.

3.13 POLYETHYLENE ENCASEMENT. All buried ductile iron pipe, including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, and all valves shall be provided with a minimum of one wrap of polyethylene encasement. Locations where ductile iron pipe shall be double wrapped with polyethylene encasement are indicated in the Contract Documents.

Polyethylene tube protection shall be installed in accordance with AWWA C105, Method A. Preparation of the pipe shall include, but is not limited to, removing lumps of clay, mud, cinders, etc., prior to installation.

Where ductile iron pipe is also embedded or encased in concrete, the polyethylene tube shall be installed over the pipe for 5 feet (1.5 m) either side of each end of the concrete encasement.

The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.

3.14 OUTLETS. Where a 12 inch (300 mm) or smaller branch outlet is indicated and the diameter of the line pipe is at least twice the diameter of the branch, a tee, a factory welded-on boss, or a tapping saddle will be acceptable.

Where a 4 inch (100 mm) or larger branch outlet is indicated on the drawings and the diameter of the branch pipe for a given diameter of parent pipe is less than equal to the maximum diameter listed herein, a factory welded-on outlet fabricated from centrifugally cast ductile iron pipe will be acceptable.

Parent Pipe Diameter Versus Maximum Branch Pipe
Diameter for Welded-On Outlets

Parent Pipe Dia inches (mm)	Max Branch Pipe Dia inches (mm)	Parent Pipe Dia inches (mm)	Max Branch Pipe Dia inches (mm)
8 ((200))	4 ((100))	30 ((750))	20 ((500))
10 ((250))	6 ((150))	36 ((900))	24 ((600))
12 ((300))	8 (200))	42 (1050))	30 (750))
14 ((350))	8 ((200))	48 (1200))	30 (750))
16 ((400))	10 ((250))	54 ((1350))	30 ((750))
18 ((450))	12 ((300))	60 ((1500))	30 ((750))
20 ((500))	14 ((350))	64 ((1600))	30 ((750))
24 ((600))	16 ((400))		

All welded-on outlets shall be rated for a working pressure of 250 psi (1700 kPa))and shall have a minimum factor of safety of 2.0. The pipe manufacturer shall provide test data and certification of proof of design. It is not necessary that these tests be performed on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design. Welded-on outlets may be provided as a radial (tee)

outlet, a tangential outlet, or a lateral outlet fabricated at a specific angle to the parent pipe (in 15° (0.262 rad)) increments between
45° and 90° (0.785 to 1.570 rad)) from the axis of the parent pipe), as indicated on the drawings. The fillet weld dimensions for welded-on outlets shall be as specified herein. Parent pipe and branch pipe shall meet hydrostatic test requirements in accordance with AWWA C151, Sec. 51-9, prior to fabrication.

Welded-on Outlet Fillet Weld Dimensions for Specified
Outlet Configurations

Radial and Lateral Outlets			Tangential Outlets		
Parent Pipe Dia inches (mm)	Branch Pipe Dia inches (mm)	Weld Fillet Size inches (mm)	Parent Pipe Dia inches (mm)	Branch Pipe Dia inches (mm)	Weld Fillet Size inches (mm)
24 (600) and smaller	24 (600) and smaller	1 x 1 (25 x 25)	8-30 (200-750)	24 (600) and smaller	1-1/4 x 1-1/4 (32 x 32)
30-48 (750-1200)	24 (600) and smaller	1-1/4 x 1-1/4 (32 x 32)	36-54 (900-1350)	24 (600) and smaller	1-1/2 x 1-1/2 (38 x 38)
54-64 (1350-1600)	24 (600) and smaller	2-1/4 x 2-1/2 (57 x 64)	60-64 (1500-1600)	24 (600) and smaller	2-1/2 x 2-1/2 (64 x 64)
42-54 (1050-1350)	30 (750)	2-1/2 x 2-1/2 (64 x 64)	42-54 (1050-1350)	30 (750)	2-1/2 x 2-1/2 (64 x 64)
60-64 (1500-1600)	30 (750)	2-3/4 x 2-3/4 (70 x 70)	60-64 (1500-1600)	30 (750)	2-3/4 x 2-3/4 (70 x 70)

All joints on welded-on branch outlets shall be made in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15, as applicable. All outlets shall be fabricated from centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured and tested in accordance with ANSI/AWWA C151/A21.51. Ni-Rod FC 55® electrodes manufactured by International Nickel Corporation (or an electrode with equivalent properties) shall be used in the manufacture of the fillet welds. Carbon steel electrodes will not be acceptable. Special Thickness Class 53 pipe shall be used for all branch pipe and parent pipe in 4 to 54 inch (100 to 1400 mm) sizes. Pressure Class 350 pipe shall be used for 60 inch and 64 inch (1500 and 1600 mm) parent pipe. After welding, each fabricated outlet shall be subjected to a 15 psi (100 kPa) air test. A soap and water solution shall be applied during the testing procedure to inspect the weld for leakage. Any welds that show air seepage shall be refabricated and retested.

Welded-on outlets shall be fabricated by the pipe manufacturer at its production facilities. Manufacturers of welded-on outlets shall have at least 5 years of satisfactory experience in the manufacture and performance of these products. The manufacturer shall have a documented welding quality assurance system and shall maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall also maintain appropriate welding procedure specifications (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records.

The type of pipe end for the branch outlet shall be as specified or indicated on the drawings. The maximum size and laying length of the welded-on branch outlet shall be as recommended by the pipe manufacturer and shall be acceptable to Engineer for the field conditions and the connecting pipe or valve. Pipe embedment material and trench backfill shall be placed and compacted under and around each side of the outlet to hold the pipe in proper position and alignment during the subsequent pipe jointing, embedment, and backfilling.

At locations acceptable to Engineer, drilling and tapping of the pipe wall for 2 inch (50 mm) and smaller pipe connections will also be acceptable, provided that the wall thickness, minus the casting allowance, at the point of connection equals or exceeds the wall thickness required for 4-thread engagement in accordance with Table A.1, Appendix A of ANSI/AWWA C151/A21.51.

3.15 <u>WALL CASTINGS</u>. Wall castings shall be provided where ductile iron pipes pass through concrete walls, unless otherwise indicated on the drawings.

Where a flange and mechanical joint piece is to connect to a mechanical joint wall casting, the bolt holes in the bell of the wall casting shall straddle the top (or the side for vertical piping) center line of the casting and shall align with the bolt holes in the flange and mechanical joint piece. The top center line shall be marked on the wall casting at the foundry.

3.16 <u>REDUCERS</u>. Reducers shall be eccentric or concentric as indicated on the drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

3.17 <u>CONNECTIONS WITH EXISTING PIPING</u>. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, a 200 mg/L chlorine solution.

3.18 INSULATED FLANGED JOINTS. Insulated flanged joints shall be installed where indicated on the drawings. In addition to one full-faced insulated gasket, each flange insulating assembly shall consist of one full-length sleeve, one insulating washer, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch (3 mm) less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the manufacturer.

3.19 CONCRETE ENCASEMENT. Concrete encasement shall be installed where indicated on the drawings. A pipe joint shall be provided within 12 inches (300 mm) of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in Master Specification Section 03300, Cast-In-Place Concrete and Master Specification Section 03200, Concrete Reinforcement. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.20 REACTION ANCHORAGE AND BLOCKING. Concrete blocking shall be installed where indicated on the drawings and shall extend from the fitting to solid, undisturbed earth and shall be installed so that all joints are accessible for repair. The dimensions of concrete reaction blocking shall be as indicated on the drawings. If adequate support against undisturbed ground cannot be obtained, restrained joints shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, restrained joints shall be furnished and installed by and at the expense of Contractor.

Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as required and as indicated on the drawings.

Coatings for appurtenances listed below shall be in accordance with Master Specification Section 09900, Painting, or in accordance with the following paragraph as indicated in the Contract Documents.

All ferrous metal clamps, rods, bolts, and other components of tapping saddles, reaction anchorages, or joint harness, subject to submergence or contact with earth or other fill material and not encased in concrete, shall be protected from corrosion by two coats of medium consistency coal tar applied in the field to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied.

Metal surfaces exposed above grade or within structures shall be given one prime coat and two finish coats of a coating acceptable to Engineer.

3.21 LEAKAGE AND PRESSURE TESTS. Pipe and fittings shall be subjected to a leakage test and a pressure test, as specified herein.

3.21.01 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

Contractor shall provide all necessary pumping equipment; piping connections between the piping and the nearest available source of test water; pressure gauges; and other equipment, materials, and facilities necessary for the tests.

All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping shall be retested by and at the expense of Contractor.

3.21.02 Visual Leakage Inspection. When a leakage test is not conducted, all joints shall be watertight and free from visible leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.22 CLEANING. The interior of all pipe and fittings shall be kept clean of any foreign matter until the work has been accepted.

3.23 SCHEDULE. See Ductile Iron Pipe Schedule 15061-S01.

End of Section

SECTION 15062

STEEL PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of steel pipe 6 inches (150 mm) in diameter and larger, together with fittings, specials, and appurtenances primarily to be used for plant applications. For steel watermain transmission piping, consult Master Specification Section 02626.

Steel pipe smaller than 6 inches (150 mm) in diameter, light wall steel pipe, miscellaneous small piping, pipe supports, concurrent cathodic protection, pressure and leakage tests, and cleaning and disinfection are covered in other sections.

Pipe trenching, bedding, and backfill are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

The size, service, and locations of steel pipelines, and the pipe material alternatives are as indicated in the Contract Documents, or in the Steel Pipe Schedule 15062-S01.

Steel piping shall be furnished and installed complete with all fittings, specials, jointing materials, appurtenances, and accessories indicated on the drawings or otherwise required for proper installation and functioning of the piping.

Piping furnished hereunder shall be complete with all jointing materials required for installation of any valves and equipment furnished by others for installation under this contract.

1.2 GOVERNING STANDARDS. Except as modified or supplemented herein, all steel pipe, fittings, and specials shall conform to the applicable requirements of the following standards:

ANSI/AWWA Standards	Title
C200	Steel Water Pipe 6 Inches (150 mm) and Larger
C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied

C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch and Larger - Shop Applied
C206	Field Welding of Steel Water Pipe
C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches Through 144 Inches (100 mm through 3600 mm)
C208	Dimensions for Steel Water Pipe Fittings.
C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
C602	Cement-Mortar Lining of Water Pipelines in Place
C606	Grooved and Shouldered Type Joints

ANSI Standard

B18.2.1	Square and Hex Bolts and Screws

ANSI/ASME Standards

B1.1	Unified Inch Screw Threads
B18.2.2	Square and Hex Nuts
B36.10	Welded and Seamless Wrought Steel Pipe

1.3 SUBMITTALS. Drawings, specifications, installation schedules, welding procedures and welder qualifications, and other data showing complete details of the fabrication, construction, weld locations, joint details and certification, and installation of pipe, fittings, specials, and connections, together with complete data covering all materials proposed for use, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Submittals shall indicate the ASTM designation for the material from which each class of pipe is fabricated.

In addition to the markings, as specified under the governing standard, Contractor's drawings shall include a complete laying schedule with piece description to show where each numbered pipe, fitting, or special is to be installed. The numbers indicated on the drawings shall correspond with those painted on the pipe.

If the flange gasket materials to be provided are other than those specified herein, Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the flanged joints specified herein and are suitable for the specified field test pressure.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Pipe, fittings, specials, and appurtenances shall at all times be handled and stored in a manner that will ensure installation in sound, undamaged condition.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN. Steel pipe, fittings, and specials may be either fabricated or mill type. In either case, all items shall be fabricated to the sizes, dimensions, and shapes indicated on the drawings or specified herein.

The specified size of fabricated pipe, fittings, and specials shall be the nominal inside diameter, in inches (mm), where 12 inches (300 mm) and smaller, and the actual inside diameter of pipe lining or the outside diameter, as specified herein, where 14 inches (350 mm) and larger. Where stab joint pipe is permitted and two or more wall thicknesses are required for pipe of the same size, pipe size may be adjusted slightly to allow the different classes of pipe to be stabbed together.

The specified size of mill pipe, fittings, and specials shall be the nominal pipe size as set forth in ANSI/ASME B36.10.

Pipe design shall be performed by Engineer or the pipe fabricator, as specified herein.

In addition to the pipe markings required by ANSI/AWWA C200, each pipe section, fitting, and special shall be clearly marked to indicate the service, wall thickness, or minimum yield strength of the pipe material.

2.1.01 Pipe Wall Thickness. When pipe design is by Engineer, the minimum wall thickness shall be as indicated in the Steel Pipe Schedule 15062-S01.

When the fabricator is required to design the pipe, the wall thickness shall be determined by the following formula, except that the minimum wall thickness and the maximum diameter to thickness ratio shall be as indicated in the Steel Pipe Schedule 15062-S01. Pipe shall be designed for all conditions indicated in the Steel Pipe Schedule 15062-S01.

$$t = (PD)/(2s),$$

where

t = the pipe wall thickness in inches (mm).

s = the allowable fiber stress in psi, (Pa) which shall not exceed 50 percent of the yield strength of the steel plate at working pressure or 75 percent of the yield strength at shop test pressure.

P = the pipe working pressure or shop test pressure in psi (Pa).

D = the pipe outside diameter, in inches (mm), or straight pipe sections or the larger outside diameter or tapered sections.

2.1.02 Fitting Dimensions. The dimensions of steel pipe fittings shall conform to ANSI/AWWA C208, as specified herein.

2.1.03 Reinforcement of Fittings and Specials. All bends, fittings, branch connections, reducers, and special sections shall be reinforced, or the pipe wall thickness shall be increased, so that the combined stresses due to internal pressure (circumferential and longitudinal) and bending will not exceed 67 percent of the yield strength of the pipe material.

Whether or not indicated on the drawings, reinforcements or additional wall thickness shall be provided as necessary to ensure that the combined stresses do not exceed the specified maximum. Unless otherwise indicated or directed, the internal pressure shall be the specified shop or field test pressure as indicated in the Steel Pipe Schedule 15062-S01 for the piping adjacent to the item in question, and the external load as indicated in the Steel Pipe Schedule 15062-S01 shall be equal to the pipe full of water.

In addition to the above and where in trench, the design of reinforcement or wall thickness shall take into consideration an external load as indicated in the Steel Pipe Schedule 15062-S01.

Wall thicknesses of reducing sections shall be not less than the required thicknesses for the larger ends.

2.1.04 Joints. Acceptable joints of the type indicated on the drawings and as specified herein shall be provided for all pipe installations in the locations indicated or accepted by Engineer. To facilitate installation, additional field-welded or mechanically coupled joints may be provided, but shall be kept to a minimum, and their locations shall be acceptable to Engineer. Field-welded joints shall not be used in pipe smaller than 27 inches (675 mm), except in locations where the interior coating can be satisfactorily repaired and inspected.

2.2 MATERIALS.

Pipe, Fittings, and Specials	ANSI/AWWA C200. All steel shall be fully killed and made to a fine austenitic grain size practice.
Flanged Joints	
Flanges	ANSI/AWWA C207, slip-on, except where otherwise permitted or required.
Dimensions and Drilling	ANSI/AWWA C207, as indicated on the drawings.
Blind Flanges	ANSI/AWWA C207, unless otherwise indicated on the drawings or specified.
Gaskets	ANSI/AWWA C207, full face type, John Crane "Style 999" neoprene, 1/8 inch (3 mm) thick, for field test pressures up to 250 psi (1700 kPa); ring type, John Crane "Style 4160" compressed aramid fiber sheet, 1/16 inch (1.5 mm) thick, for field test pressures above 250 psi (1700 kPa). The products of other manufacturers and other products of the manufacturer named herein will not be acceptable unless a certificate of product suitability is submitted as set forth in the Submittals paragraph herein.

Insulated Flanges

Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.
Insulation Kits	As manufactured by Central Plastics or PSI Industries.
Insulating Gaskets	Type E, pyrox 1E glass reinforced epoxy, 1/8 inch (3 mm) thick, with Buna-N sealing element.
Bolt Insulating Sleeves	Mylar, 1/32 inch (0.7 mm) thick.
Insulating Washers	Phenolic laminate, 1/8 inch (3 mm)thick, one for each flange bolt.
Backing Washers	Steel, 1/8 inch (3 mm) thick, two for each flange bolt.

Flange Bolting

Material	ANSI/AWWA C207.
Type	Bolt and nut; bolt-stud and two nuts permitted for 1 inch (25 mm) and larger.
Bolts and Bolt-Studs	
Length	Such that ends project 1/4 to 1/2 inch (6 to 12.7 mm) beyond surface of nuts.
Ends	Chamfered or rounded.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2A fit. Bolt-studs may be threaded full length.
Bolt Head Dimensions	ANSI B18.2.1; regular pattern for square, heavy pattern for hexagonal.
Nuts	Hexagonal.
Dimensions	ANSI/ASME B18.2.2, heavy,

	semifinished pattern.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2B fit.
Stab Joints	Bell-and-spigot, with rubber gasket as sole element depended upon for watertightness.
Bells and Spigots	Rolled groove, Carnegie shape, or fabricated type, as needed or permitted.
Rubber Gaskets	Continuous O-ring; ANSI/AWWA C200, Section 3.6, except basic polymer shall be synthetic rubber. Natural rubber will not be acceptable.
Mechanical Couplings	
Insulating	Baker "Series 216", Dresser "Style 39", or Smith-Blair "416"; without pipe stop.
Reducing	Baker "Series 220", Dresser "Style 62", or Smith-Blair "413" and "415"; without pipe stop.
All Others	Baker "Series 200", Dresser "Style 38", or Smith-Blair "411 Flexible Coupling"; without pipe stop.
Restrained Joints	Of the type indicated on the drawings or as specified herein.
Lugs or Collars	ASTM A283, Grade B or C; or ASTM A36.
Tie Bolts	ASTM A193, Grade B7.
Threading	ANSI/ASME B1.1, Class 2A fit, coarse thread series for 7/8 inch (22 mm) and smaller, and 8-thread series for 1 inch (25 mm) and larger.
Ends	Chamfered or rounded.
Nuts	Hexagonal, ASTM A194, Grade 2H or better.

Threading	As specified for tie bolts, except Class 2B fit.
Dimensions	ANSI/ASME B18.2.2, heavy semifinished pattern.
Flat Washers	Hardened steel, ASTM A325.
Flanged Coupling Adapters	Dresser "Style 128" or Smith-Blair "913"; with anchor studs of sufficient size and number to withstand test pressure.
Grooved Couplings (when joint movement and deflection is not acceptable)	ANSI/AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
Grooved Couplings (when joint movement and deflection is acceptable)	ANSI/AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 22" or "Style 77", as needed.
Small Branch Connections	
Pipe Nipples	Seamless black steel pipe, ASTM A53, standard weight (Schedule 40).
Welding Fittings	
Threaded Outlets	Bonney "Thredolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Welded Outlets	Bonney "Weldolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Coatings and Linings	
Coal Tar Enamel	ANSI/AWWA C203.
Liquid Epoxy	ANSI/AWWA C210.
Tape Coating	ANSI/AWWA C209 and C214.
Cement Mortar	ANSI/AWWA C205 and C602.
Cement	ASTM C150, Type II.
Sand	ANSI/AWWA C205, Section 4.2.3,

	except sand for field-applied lining shall pass a No. 16 (1.18 mm) sieve.
Epoxy Bonding Agent	ASTM C881, Type II, moisture insensitive and suitable for service conditions.
Latex Admixture	Euclid "Euco Flex-Con" or Sika "SikaLatex".
Medium Consistency Coal Tar	Carboline "Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol".
Bituminous Filler for Wall Fittings	Plastic asphalt roof cement, asbestos-free, ASTM D4586, Type II.
Watertight Pipe Sleeves	Thunderline Corporation "Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts and nuts.
Anchor Bolts	ASTM A307.

2.3 ENDS OF SECTIONS.

2.3.01 For Field Welding. Ends of pipe, fittings, and specials for joints butt-welded in the field shall have the ends beveled for butt welding in accordance with the governing standards.

Ends of pipe, fittings, and specials for field-welded lap joints shall have both the bell and the spigot expanded by pressing (not rolling) to obtain the required shape and welding tolerances.

2.3.02 For Fitting with Flanges. Ends to be fitted with slip-on flanges shall be prepared to accommodate the flanges in accordance with the governing standards.

2.3.03 For Stab Joints. Stab joints shall be designed so that the gasket will maintain a watertight joint under all conditions of service, including expansion, contraction, and earth settlement. The gasket shall not support the entire weight of the pipe. Spigot ends shall have a groove to retain the gasket. Pipe ends shall be self-centering without the aid of the gasket.

2.3.04 For Mechanical Couplings. Ends to be joined by mechanical couplings shall be plain end type in accordance with the governing standard. In addition, pipe seam welds on ends to be joined by mechanical couplings shall be ground flush to permit slipping the coupling in at least one direction to clear the pipe joint.

2.3.05 For Grooved Couplings. Ends to be joined by grooved couplings shall be of the cut grooved or shouldered type as specified herein, conforming to the governing standard and as recommended by the coupling manufacturer for the size and wall thickness of the pipe, fitting, or special being coupled, and for the maximum test or working pressure to which the couplings will be subjected.

2.3.06 For Flanged Coupling Adapters. Ends to be fitted with flanged coupling adapters shall be plain end type in accordance with the governing standard for mechanical couplings. Welds shall be ground flush to permit installation of the coupling, and holes shall be field drilled at the proper location for anchor studs.

2.3.07 For Connection to Dissimilar Pipe Materials. Steel pipe connections to buried or submerged concrete pipe or cast iron pipe shall be made with insulated flanges.

2.4 SEAMS. Except for seamless mill-type pipe, all piping shall be made from steel plates rolled into cylinders or sections thereof with the longitudinal seams butt-welded, or shall be spirally formed and butt-welded. There shall be not more than two longitudinal seams. Girth seams shall be butt-welded and shall be spaced not closer than 10 feet (3 m) apart except in specials and fittings.

2.5 PIPE LENGTHS. Straight pipe section lengths shall be as specified herein, unless otherwise indicated on the drawings.

All pipe to be connected with mechanical couplings shall be fabricated so that the space between pipe ends within the couplings will not exceed the amount recommended by the coupling manufacturer, but will be at least 1/2 inch (12 mm).

2.6 SMALL BRANCH CONNECTIONS. Branch connections 2-1/2 inches (63 mm) and smaller shall be made with welding fittings with threaded outlets. Where the exact outlet size desired is in doubt, but is known to be less than 1 inch (25 mm), a 1 inch (25 mm) outlet shall be provided and reducing bushings used as needed.

Branch connections sized 3 through 12 inches (75 through 300 mm) shall be made with pipe nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as needed to meet design and testing requirements.

Small branch connections shall be so located that they will not interfere with joints, supports, or other details, and shall be provided with caps or plugs to protect the threads during shipping and handling.

2.7 ACCESS MANHOLES. Access manholes shall be provided in the locations indicated on the drawings. The type of manholes shall also be indicated on the drawings. An access manhole marker post shall be furnished and installed adjacent to each buried access manhole as indicated on the drawings.

2.7.01 Type I Manhole. A Type I manhole shall consist of a 24 inch (600 mm) flanged outlet with a blind flange cover. Covers shall be fabricated from steel plate with thickness as indicated on the drawings, and shall have two handles fabricated from 1 inch (25 mm) diameter rod.

At the option of Contractor and subject to acceptance by Engineer, reinforced or dished covers of lighter weight and equal strength may be provided.

2.7.02 Type 2 Manhole. A Type 2 manhole shall be bolted or hinged type, conforming to Figure 13-26 of AWWA M11 and shall be suitable for a pressure as indicated on the drawings.

> Covers. Manhole covers shall be fabricated from steel plate with thickness as indicated on the drawings.
>
> Reinforcing Pads. Reinforcing pads shall be provided as indicated on the drawings.

2.7.03 Type 3 Manholes. A Type 3 manhole shall provide an elliptical clear opening at least 14 by 18 inches (350 by 450 mm) and shall be of self-sealing construction, with two steel yokes and a lifting handle on the cover. Each cover shall be hinged from the outside and designed to swing in. The manholes shall withstand, without leaking, the test pressure specified for the pipe in which they are to be installed. The design shall be in accordance with the ASME Code for Unfired Pressure Vessels. Access manholes shall be designed and installed so that flow in the pipe is not obstructed.

2.8 DRAINS AND VENTS. Drains and vents shall be provided at the locations and in the sizes indicated on the drawings. Pipe used for drain and vent piping shall be ASTM A53 standard weight, black steel pipe. Drain valves shall be hose valves. Vent valves shall be resilient seat globe valves. Drain and vent valves shall comply with the requirements of Master Specification Section 15100, Miscellaneous Valves.

2.9 FLANGED JOINTS. Flange faces of flanged joints shall be normal to the pipe axis. Angular deflection (layback) of the flange faces shall not exceed the allowable set forth in Section 4.3 of ANSI/AWWA C207. All flanges shall be refaced after welding to the pipe, if necessary to prevent distortion of connecting valve bodies from excessive flange bolt tightening and to prevent leakage at the joint.

Pipe lengths and dimensions and drillings of flanges shall be coordinated with the lengths and flanges for valves, pumps, and other equipment to be installed in the piping. All mating flanges shall have the same diameter and drilling and shall be suitable for the pressures to which they will be subjected.

Flanges shall be of the slip-on type, except that welding-neck or slip-on flanges welded to short lengths of pipe shall be used where installation of flanges in the field is permitted or required.

2.10 STAB JOINTS. Rubber-gasketed bell-and-spigot (stab type) steel pipe shall be furnished where indicated or specified. The design of the rubber-gasketed bell-and-spigot joints shall be subject to review and acceptance by Engineer.

The difference in circumferential measurements between the outside of the spigot end and the inside of the bell shall be not more than 0.12 inch (3 mm). For pipe with a wall thickness greater than 11/32 inch (8.7 mm), and for 60 inch (1500 mm) and larger pipe, a bar type fabricated spigot shall be furnished. Bends in the pipe wall forming each bell shall have a radius of at least 15 times the pipe wall thickness.

Contractor shall obtain from the fabricator and shall submit certification that the pipe joints will withstand working pressures and test pressures equal to those specified, and documentation that joints of the type proposed have performed satisfactorily under similar conditions.

2.11 MECHANICAL COUPLINGS. The middle ring of mechanical couplings shall have a thickness at least equal to the wall thickness specified herein for the size of pipe on which the coupling is to be used. If the manufacturer's standard thickness is less, that thickness may be used unless allowable pressures are exceeded. The length of each middle ring shall be not less than 10 inches (250 mm) for 36 inch (900 mm) and larger pipe and not less than 7 inches (175 mm) for pipe smaller than 36 inches (900 mm).

When required, the middle rings shall be shop galvanized and the remaining components shall be cleaned and shop primed with 2 mils (50 μm) of a universal primer.

When required, middle rings shall be prepared for coating in accordance with the coating manufacturer's instructions and shall then be coated with 5 mils (125 μm) of liquid epoxy in accordance with ANSI/AWWA C210. The remaining components shall be cleaned and shop primed with 2 mils (50 μm) of a universal type primer.

2.12 GROOVED COUPLINGS. Grooved couplings shall be provided where indicated on the drawings and shall be sized for proper installation on the pipe ends provided. The couplings shall have movement and deflection requirements as needed.

After fabrication, all housing clamps forming the coupling shall be cleaned and primed (as specified for the pipe) by the coupling manufacturer.

2.13 RESTRAINED JOINTS. Restrained joints shall be shall be flanged, welded, flanged coupling adapters with anchor studs, or harnessed, as required, and as specified or indicated on the drawings.

Where indicated on the drawings, mechanically coupled, grooved coupling, or stab type joints shall be restrained with harness bolts and lugs or collars. Joint harnesses shall conform to the details indicated on the drawings. Lugs or collars shall be shop welded to the pipe and coated as specified for the adjacent pipe.

2.14 PROTECTIVE COATINGS AND LININGS. All steel pipe, fittings, specials, wall fittings, and accessories shall be lined, coated, or wrapped as specified herein.

2.14.01 Type of Coating and Lining. Surface preparation shall be in accordance with the coating or lining manufacturer's instructions. Types of protective coating and lining shall be as follows:

Exterior Surfaces in Interior Locations	Shop-applied universal primer. Field painting is covered in Master Specification Section 09900,Painting.
Exterior Surfaces Underground, Including those Encased in Concrete	Coal tar enamel, ANSI/AWWA C203, cement mortar, ANSI/AWWA C205, liquid epoxy, ANSI/AWWA C210, or tape coating, ANSI/AWWA C214, as specified herein. The governing standards shall be as modified herein.
Exterior Surfaces in Contact with Potable Water or Submerged in Water Treatment Process Waters	Cement mortar, ANSI/AWWA C205, or liquid epoxy, ANSI/AWWA C210, as specified herein.
Interior Surfaces	Coal tar enamel, ANSI/AWWA C203, cement mortar - shop applied, ANSI/AWWA C205, liquid epoxy, ANSI/AWWA C210, or cement mortar - field applied, ANSI/ AWWA C602, as specified herein. The governing standards shall be as modified herein.
Pipe Joints	

Couplings	Shop coating as specified for each type of coupling. Field coating as specified for ends of sections.
Ends of Sections	As specified herein.
Machined Surfaces	Rust-preventive compound.

2.14.02 Modifications to the Governing Standards.

2.14.02.01 Coal Tar Enamel Coating. Except as modified or supplemented herein, all materials and their application shall be in accordance with ANSI/AWWA C203, and the appendix thereto when specified herein.

Exterior surfaces of all steel pipe, fittings, and specials which are to be installed underground or which are to be encased in concrete shall be blast cleaned, primed, and coated in the shop with hot-applied coal tar enamel followed by a single layer of outerwrap consisting of glass-fiber felt, polyethylene-kraft paper, or polyethylene-elastomer laminate. The outerwrap shall be coated with shop-applied whitewash or a single layer of kraft paper.

The application of coal tar enamel coating materials, including the preparation of surfaces; priming; and lining and coating of the pipe, fittings, and specials, shall be done in the shop by an established pipe lining and coating company acceptable to the manufacturer of the coal tar enamel materials and to Engineer. Exterior coating shall not be applied until after the specified interior cement mortar lining (if required) has been applied and cured. Repairs of any damage to the shop coating and the field coating of ends where coatings have been held back shall be done by experienced and qualified personnel.

The pipe lining and coating company shall submit an affidavit of compliance indicating that all instructions and requirements of the coating materials manufacturer will be followed and that the company is acceptable to the materials manufacturer.

2.14.02.02 Shop-Applied Cement Mortar Lining. Unless otherwise acceptable to Engineer, cement mortar lining for all 36 inch (900 mm) and smaller steel pipe shall be shop applied. For pipe larger than 36 inches (900 mm), the lining shall be shop applied, or Contractor shall have the option of shop or field applied lining as specified herein. Except as modified herein, shop-applied mortar linings shall comply with ANSI/AWWA C205.

Specials. Wire fabric reinforcement shall be used in the lining of fittings and specials in accordance with Section 4.4.5 of ANSI/AWWA C205.

Adjacent to Valves. If the specified nominal pipe size is the actual outside diameter, cement mortar lining installed in steel pipe adjacent to butterfly valves shall be tapered so that the lining material will not interfere with the valve disc during valve operation.

2.14.02.03 Shop-Applied Tape Coat. Except as modified or supplemented herein, shop-applied tape coating shall comply with ANSI/AWWA C214. The tape coating system shall consist of a primer layer, an inner layer of tape for corrosion protection, and two outer layers of tape for mechanical protection. The total thickness of the tape coating system shall be at least 80 mils (2 mm). The outer layer of tape shall be white.

2.15 SHOP INSPECTION AND TESTING. Except as otherwise indicated or acceptable to Engineer, all materials and work shall be inspected and tested by the pipe manufacturer in accordance with ANSI/AWWA C200. All costs in connection with such inspection and testing shall be borne by Contractor.

Copies of all test reports shall be submitted as set forth in Master Specification Section 01080, Project Submittals.

Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

2.15.01 Owner's Inspection at the Shop. If Owner elects to inspect any work or materials, as permitted under Section 1.4 of ANSI/AWWA C200, all costs in connection with the services of Owner's inspector will be paid for by Owner. Additional weld test specimens shall be furnished to Owner's inspector for testing by an independent testing laboratory whenever, in the judgment of Owner's inspector, a satisfactory weld is not being made. Test specimens shall also be furnished when Owner's inspector desires. The entire cost of obtaining, inspecting, and testing of such additional specimen plates, welds, or materials will be borne by Owner. If any specimen is found not to conform to the specified requirements, the materials represented by the specimen will be rejected. The expense of all subsequent tests due to failure of original specimens to comply with the specifications shall be the responsibility of Contractor.

Work to be performed by Owner's inspector at the fabricating shop will include checking of flange alignment after welding to the pipe and tolerances of stab joints, when applicable.

In addition to making or witnessing all specified tests and submitting any required reports to Engineer and Owner, Owner's inspector will submit written reports to Contractor concerning all materials rejected, noting the reason for each rejection.

Inspection by Owner's inspector, or failure to provide inspections, shall not relieve Contractor of his responsibility to provide materials and to perform the work in accordance with the Contract Documents.

2.15.02 Welding Procedures, Welder Qualifications, and Testing. When additional welding requirements are required, they shall be as specified in this paragraph.

All welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in ANSI/AWWA C200. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.

All shop welds on steel pipe and fittings shall be ultrasonically tested by qualified and certified operators employed by the fabricator. Shop ultrasonic weld tests shall be in accordance with Section 9 of API 5L, 37th Edition. All costs for ultrasonic shop testing shall be paid by Contractor. Contractor and Engineer shall each be furnished a copy of all ultrasonic test reports.

Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing ultrasonic and radiographic tests shall be qualified and certified according to the requirements of SNT-TC-1A.

Nondestructive examination procedures shall be submitted in accordance with Master Specification Section 01080, Project Submittals at the time welding procedures are submitted. Records of inspection, nondestructive examination, and material certification shall be furnished to Engineer.

All costs for inspection of shop welds shall be paid by Contractor.

PART 3 - EXECUTION

3.1 FIELD INSPECTION. All shop-applied exterior coal tar enamel or tape coatings on pipe, fittings, or specials shall be electrically inspected for holidays and other defects, and repaired if necessary. All electrical inspection shall be made in accordance with Section 6 of ANSI/AWWA C203.

Inspection and repair of exterior coatings shall be performed by and at the expense of Contractor, after receipt of the pipe, fittings, or specials on the job and before installation. Electrical inspection of exterior coal tar enamel or tape coatings after installation of the pipe, fitting, or special in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged by handling during installation.

3.2 PROTECTION AND CLEANING. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted.

Precautions shall be taken to ensure that foreign matter does not enter the pipe during jointing, lining repair, or inspection operations.

3.3 ALIGNMENT AND GRADE. Pipe shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Curves in stab joint pipe may be formed by opening the joint. Maximum joint openings and deflections shall be as recommended by the pipe manufacturer. In welded pipe, deflections up to 4-1/2 degrees (0.079 rad) may be made by shop-mitering one end of one pipe. Deflections up to 22-1/2 degrees (0.393 rad) may be made by shop-mitering the ends of two adjacent sections of pipe by equal amounts. Deflections greater than 22-1/2 degrees (0.393 rad) shall be made by use of fabricated bends.

High points which allow air to collect in pipelines will not be permitted unless an air release valve is indicated on the drawings at that location.

When pipelines must be closely controlled, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.4 INSTALLATION.

3.4.01 Buried Piping. For buried piping, all trenching, embedment, and backfilling shall conform to Master Specification Section 02221, Trenching, Backfilling, and Compacting and the details indicated on the drawings.

Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug. All water in the trench shall be removed prior to removing the plug.

Pipe embedment and backfilling shall closely follow the installation and jointing of steel pipe in the trench to prevent flotation of the pipe by water and longitudinal movement caused by thermal expansion or contraction of the pipe.

For restrained joint pipe, not more than 160 feet (48 m) of pipe shall ever be exposed ahead of the backfilling in any section of trench. The backfill adjacent to field joints may be temporarily omitted to provide adequate space for field coating the joints. Closure welds on restrained joint pipe shall be made during the cool part of the day.

3.4.02 Out-of-Round Pipe. Pipe which deviates from a true circle by more than 1 percent shall be laid with its larger diameter vertical, or by using struts or jacks on continuous head and sill timbers to correct the vertical diameter where permitted by Engineer. Struts or jacks shall be left in place until the joints at each end have been completed and embedment and backfill for the section have been placed to at least 12 inches (300 mm) above the top of the pipe. Final inspection, repair, and checking of interior lining shall be performed after the struts or jacks have been removed.

3.4.03 Elongating Vertical Diameter. When required, the vertical diameter of all buried pipe with minimum cover depth as required or so indicated on the drawings, shall be elongated (before backfilling of the trench) by an amount equal to 2 percent of the nominal diameter.

The vertical diameter may be elongated by controlled placement of pipe embedment material or by struts or jacks installed between continuous head and sill timbers padded to protect the lining. Struts or jacks shall be left in place until the joints at each end have been completed and the embedment and backfill for the section have been placed to at least 12 inches (300 mm) above the top of the pipe. Final inspection, repair, and checking of interior lining shall be performed after the struts or jacks have been removed.

3.4.04 Pipe Deflection. After completion of backfilling and before acceptance of the Work, all pipe larger than 30 inches (750 mm) in diameter shall be tested for excessive deflection by measuring the actual inside vertical diameter. Deflection measurements will be made by Engineer. Pipe with diametral deflection exceeding 2 percent of the nominal inside diameter shall be uncovered and the bedding and backfill replaced as needed to prevent excessive deflection. After replacing bedding and backfill, the pipe shall be retested.

3.4.05 Flanged Joints. Care shall be taken in bolting flanged joints to avoid restraint on the opposite end of the piece, which would prevent pressure from being evenly and uniformly applied upon the gasket. The pipe or fitting must be free to move in any direction during installation of bolts. Bolts shall be gradually tightened in a crisscross pattern, to ensure a uniform rate of gasket compression around the entire flange.

Special care shall be taken when connecting piping to pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before any bolts are installed in the flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts then shall be loosened and the process repeated until no movement is observed.

3.4.06 Couplings. Surfaces of pipe ends and couplings in contact with the sealing gasket shall be clean and free from foreign material when the coupling is installed on the pipe. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. All bolts shall be tightened by approximately the same amount, with all parts of the coupling square and symmetrical with the pipe. Following installation, the exterior coating of each coupling shall be touched up or reprimed.

3.4.07 Insulated Flanged Joints. Insulated flanged joints shall be installed where indicated on the drawings. In addition to one full-faced insulating gasket, each flange insulating assembly shall consist of one full-length sleeve, one insulating washer, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch (3 mm) less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the manufacturer.

3.4.08 Stab Joints. Gasket installation and other jointing procedures shall conform to the instructions and recommendations of the pipe manufacturer. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before making the joint. The lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Measurements shall be taken at the joints after installation to ensure that the specified clearances have not been exceeded.

3.4.09 Welded Joints. All welds shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be watertight. Butt welds shall be used for all welded joints in pipe assemblies and in the fabrication of bends and other specials. Field-welded joints, where permitted, shall be either butt-welded or lap-welded.

Field welding of joints shall conform to ANSI/AWWA C206. Single field-welded butt joints with outside backing rings may be used for pipe larger than 27 inches

(675 mm) in diameter. Backing rings will not be permitted for 27 inch (675 mm) and smaller pipe. Butt straps shall be welded on both the inside and outside of the pipe and at each end of the pipe and strap to avoid stress multiplication.

Field-welded lap joints shall have fillet welds both inside and outside to avoid stress multiplication. The outside weld may be a seal weld.

Testing of welded joints shall be standard, or special procedure, as specified herein.

3.4.09.01 Standard Inspection and Testing. When specified herein, standard shop inspection and testing shall be in accordance with the shop inspection and testing provisions herein.

Field weld test specimens shall be furnished to Engineer for testing by an independent testing laboratory whenever, in the judgment of Engineer, a satisfactory weld is not being made. Test specimens shall also be furnished when Engineer desires. All costs for this testing will be paid by Owner.

3.4.09.02 Special Procedure Inspection and Testing. When specified herein, special procedure shop inspection and testing shall be in accordance with the shop inspection and testing provisions specified herein. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.

The welder qualification testing for field welding shall be conducted at the project site. Results of previous qualification tests will not be accepted. Contractor shall provide the services of an independent testing laboratory to perform the welder qualification. Copies of all test data and certifications shall be submitted to Engineer. All costs of welder qualification testing shall be paid by Contractor.

Upon completion of each field-welded joint, the welding operator shall mark his regular identification number and the last two digits of the year the work was completed, or Contractor may have a records system that traces a welder's work. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round-nose types, are used.

Field welds will be randomly inspected and tested by an independent testing laboratory as directed by Engineer. Field lap welds will be inspected by magnetic particle or dye penetration methods. Field butt welds will be inspected by the radiographic method and in accordance with the acceptance criteria of API 1104. Contractor shall inform Engineer before welded joints are to be backfilled so that the joint may be inspected. Contractor shall assume all costs of exposing joints that were backfilled before inspection.

Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.

Engineer may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein.

Except as otherwise specified herein, all costs for inspection and testing of field welds by the independent testing laboratory will be paid by Owner. If the weld is defective, the inspection costs shall be paid by Contractor. Defective welds shall be repaired and retested at Contractor's expense.

Test reports of all laboratory tests shall be submitted as provided for in Master Specification Section 01060, Quality Control.

3.4.10 Flanged Coupling Adapters. Flanged coupling adapters shall be provided where indicated on the drawings and shall be installed in accordance with the coupling manufacturer's recommendations. After the pipe is in place and all bolts have been properly tightened, the location of holes for the anchor studs shall be determined and field drilled. Hole diameter shall be not more than 1/8 inch (3 mm) larger than the diameter of the stud projection. Anchor stud holes shall extend completely through the pipe wall and lining material.

The inner surfaces of the coupling shall be prepared for painting in accordance with the paint manufacturer's instructions and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except flange mating surfaces, shall be cleaned and shop primed with a universal primer.

3.5 WALL SLEEVES. Wall sleeves shall be provided where indicated on the drawings and shall be provided where steel pipe passes through concrete or masonry walls, unless otherwise noted. Where harness lugs are attached to wall sleeves, the sleeves shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint wall sleeves, holes in the mechanical joint bells and flanges shall straddle the top (or side for vertical piping) center line. The top (or side) center line shall be marked on each flange and mechanical joint piece at the fabricating shop.

3.6 PIPE ANCHORS, BLOCKING, ENCASEMENT, HANGERS, AND SUPPORTS. Pipe anchors, blocking, hangers, and supports shall be installed where and as indicated on drawings and shall be fabricated in accordance with Master Specification Section 15140, Pipe Supports and the details indicated on the drawings, and shall be furnished and installed complete with all concrete bases, anchor bolts and nuts, plates, rods, and other accessories required for proper support of the piping. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports. Where the details must be modified to fit the piping and structures, all such modifications shall be subject to acceptance by Engineer. Unless otherwise permitted, lugs for lateral or longitudinal anchorage shall be shop welded to the pipe.

Concrete reaction anchorage, blocking, encasements, and supports shall be provided as indicated on the drawings or as permitted by Engineer. Concrete and reinforcing steel for anchorages, blocking, encasements, and supports shall conform to Master Specification Section 03300, Cast In Place Concrete and Master Specification Section 03200 Concrete Reinforcement. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.7 PROTECTIVE COATINGS AND LININGS.

3.7.01 Field Coating and Repair. Entry into the pipe or pipeline for application of interior linings to unlined ends shall be from open ends or through access manholes, except as otherwise permitted by Engineer. Pour holes shall be permitted as specified herein, and shall consist of 4 inch (100 mm) standard weight black steel pipe welded to the pipe to be lined and covered with a bolted blind flange***.***

Field repair of shop-applied exterior coatings and interior linings shall conform to the following:

For Field-Welded Joints

Coal Tar Enamel	Hold back coating and lining 4 inches (100 mm) from joint. Field repair in accordance with ANSI/AWWA C203.
Cement Mortar	Hold back coating and lining 4 inches (100 mm) from joint. Field repair in accordance with Section 4.6 of ANSI/AWWA C205 as modified herein.
Liquid Epoxy	Hold back coating 4 inches (100 mm) from joint. Field repair in accordance with ANSI/AWWA C210.
Tape Coating	Hold back at least 4 inches (100 mm) from joint. Field repair in accordance with ANSI/AWWA C209, except the total applied tape thickness shall be not

	less than 80 mils (2 mm).
For Flanged Joints	Extend lining to ends of pipe. The coating of exterior surfaces is covered in Master Specification Section 09900, Painting.
For Stab Joints	
Coal Tar Enamel	Hold back the coating on spigots and the lining in bells from joints in accordance with ANSI/AWWA C203. Field repair exterior coating with 20 mils (500 µm) of medium consistency coal tar. Repair lining in accordance with ANSI/AWWA C203.
Cement Mortar	Hold back the coating on spigots and the lining in bells from joints as specified for coal tar enamel coatings in ANSI/AWWA C203. Field repair in accordance with Section 4.6 of ANSI/AWWA C205 as modified herein.
Liquid Epoxy	Hold back the coating on spigots and the lining in bells from joints, and field repair in accordance with ANSI/AWWA C210.
Tape Coating	Hold back the coating on spigots as specified for coal tar enamel in ANSI/AWWA C203. Field repair in accordance with ANSI/AWWA C209.
For Mechanically Coupled Joints	
Coal Tar Enamel	Hold back coating 16 inches (400 mm) from joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Lining shall extend to end of pipe. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.

Cement Mortar	Hold back coating 16 inches (400 mm) from joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Lining shall extend to end of pipe. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Liquid Epoxy	Shop coat in accordance with ANSI/AWWA C210. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Tape Coating	Hold back coating 16 inches (400 mm) from joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.

For Grooved Coupled Joints

Coal Tar Enamel	Hold back coating 6 inches (150 mm) at joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Lining shall extend to end of pipe. Field repair exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Cement Mortar	Hold back coating 6 inches (150 mm) at joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with

	ANSI/AWWA C203. Lining shall extend to end of pipe. Field repair exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Liquid Epoxy	Shop coat in accordance with ANSI/AWWA C210. Field repair exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Tape Coating	Hold back coating 12 inches (300 mm) at joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.

3.7.02 <u>Modifications to the Governing Standards</u>.

3.7.02.01 <u>Field Repair of Shop-Applied Cement Mortar Lining</u>. Field repair of interior joint surfaces shall be done in accordance with Section 4.6.2 of ANSI/AWWA C205, except that an epoxy bonding agent and latex admixture shall be used in conjunction with the sand and cement mortar. The addition of lime or pozzolan will not be permitted.

The exposed steel shall be thoroughly cleaned and all grease shall be removed. A coat of epoxy bonding agent shall be applied over the area to be lined in accordance with the manufacturer's recommendations. A soupy mixture of cement and water shall be applied over the epoxy after it becomes tacky. Cement mortar to which the latex admixture has been added shall then be packed into the area to be patched and screeded off level with the adjacent cement mortar lining. The patched area shall be given an initial floating with a wood float, followed by a steel trowel finish.

Defective or damaged shop-applied cement mortar linings shall be removed, the surfaces cleaned, and the lining repaired as specified above for joint repair.

3.7.02.02 <u>Field-Applied Cement Mortar Lining</u>. Except as modified herein, field-applied mortar linings shall comply with ANSI/AWWA C602.

Specials. Wire fabric reinforcement shall be used in the lining of fittings and specials in conformance with Section 4.4.5 of ANSI/AWWA C205.

Field Repair. Defective or damaged field-applied cement mortar linings shall be removed, the surfaces cleaned, and the lining repaired as specified for shop-applied cement mortar linings.

3.8 CONNECTIONS WITH EXISTING PIPING. Connections between new work and existing piping shall be made with suitable fittings for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner.

Facilities shall be provided for dewatering and for disposal of the water removed from the dewatered lines and excavations without damage to adjacent property.

For pipelines which will convey potable water, special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with or dipped in a 200 mg/L chlorine solution.

3.9 PROVISIONS FOR CATHODIC PROTECTION. Provisions shall be made for cathodic protection of underground steel pipelines. An insulated type joint shall be provided at each connection to a steel water tank, each branch connection to an existing or future water line, each connection between concrete pipe or ductile iron pipe and steel pipe, each connection through a structure wall, and where indicated on the drawings. An electrical bond shall be provided across all other gasketed pipeline joints. Test lead stations for monitoring electrical currents on the pipeline shall be provided at locations indicated on the drawings.

3.9.01 Insulated Joints. Insulated flange type joints shall be provided where indicated on the drawings or specified. After installation, protective coatings shall be provided around the joint as specified herein.

3.9.02 Electrical Bond Across Rubber-Gasketed Joints. Two electrical bonding cables shall be provided to and across each mechanical coupling and across each rubber-gasketed stab joint. Before the field joint coating is applied to mechanical couplings, two small areas of metal shall be exposed on the pipe surface each side of the coupling, on the middle ring, and on each follower ring. Before the field joint coating is applied to stab joints, two small areas of metal shall be exposed on each side of the joint. Each area shall be thoroughly cleaned, and two cathodic protection cables shall be bonded to the pipe, one on either side of the joint, and to the middle ring and follower rings for mechanically coupled joints. Each cable shall be bonded by the thermite process. The completed connections and exposed metal surfaces shall be coated as specified for field repair of coatings.

3.9.03 Electrical Bond Across Valves and Flanges. Two electrical bonding cables shall be provided across valves and flanged connections other than insulated flanges. The electrical bond shall be provided as specified for bond across rubber-gasketed joints.

3.9.04 Bonding Cables. Bonding cable and test lead wires shall be not less than 6 AWG (16 mm^2), Type CP copper cathodic protection cable, with low density, high molecular weight polyethylene insulation.

3.9.05 Test Lead Stations. Test lead stations shall be provided where specified or indicated. The test lead stations shall be as specified herein. The test lead wires shall be terminated on the ground surface in a standard connection box at a protected location acceptable to Engineer. Standard connection boxes for test lead stations shall be C.P. Test Services "NM-7" plastic terminal boxes, 18 inches (450 mm) long, with 5 inch (125 mm) inside diameter, a locking cast iron lid, a terminal block with seven terminals, and the inscription "CP TEST" cast into its cover.

3.10 LEAKAGE AND PRESSURE TESTS. After installation, steel piping shall be subjected to a leakage and pressure test.

3.10.01 Leakage. All steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.10.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.11 DISINFECTION. The steel piping shall be disinfected after installation as specified herein. The disinfection is to be as specified in Master Specification Section 02675, Disinfection of Water Distribution System.

End of Section

SECTION 15063

LIGHT WALL STEEL PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of light wall steel pipe, fittings, specials, and appurtenances.

Miscellaneous small piping and pipe supports are covered in Master Specification Section 15065, Miscellaneous Steel Pipe, Tubing, and Accessories and Master Specification Section 15140, Pipe Supports .

Light wall steel piping shall be furnished and installed complete with all fittings, specials, flanges, couplings, joint harnesses, anchors, anchor bolts, anchor inserts in concrete, expansion anchors, flange gaskets, flange bolts and nuts, pipe supports and hangers, wall fittings, blind flanges, connections, appurtenances, and accessories, as indicated on the drawings, or otherwise specified herein for proper installation and functioning of the piping.

Piping furnished shall be complete with all jointing materials required for installation of any valves and equipment furnished by others for installation under this contract.

1.2 GOVERNING STANDARDS. Except as modified or supplemented herein, all light wall steel pipe, fittings, and specials shall conform to the applicable requirements of the following standards:

ANSI/AWWA Standards	Title
C200	Steel Water Pipe 6 Inches [150 mm] and Larger
C206	Field Welding of Steel Water Pipe
C208	Dimensions for Steel Water Pipe Fittings

1.3 SUBMITTALS. Drawings, specifications, and other data showing complete details of the fabrication, construction, weld locations, and installation of pipe, fittings, specials, and connections, together with complete data covering all materials proposed for use, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Pipe, fittings, specials, and appurtenances shall at all times be handled and stored in a manner that will ensure installation in sound, undamaged condition. Handling methods and equipment used shall prevent damage to the coating and shall include the use of wide canvas slings and wide padded skids. Bare cables, chains, hooks, metal bars, or narrow skids shall not be used.

All pipes shall be carefully supported during shipment on padded saddles not less than 12 inches (300 mm) wide. Each end of each length of pipe, fitting, or special shall be laterally supported and braced as needed to ensure that it will maintain a true circular shape. Pipe, fittings, and specials shall be separated so that they do not bear against each other, and the whole load shall be securely fastened to prevent movement in transit.

Any pipe section, fitting, or special, which shows dents, kinks, abrupt changes of curvature other than specified, or other injuries, will be rejected. Contractor shall, at his expense, replace or recondition each rejected section. Reconditioning procedures shall be acceptable to Engineer. Coatings removed in reconditioning pipe, fittings, or specials shall be replaced as specified for the original coating.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN. Light wall steel pipe, fittings, and specials may be either fabricated or mill type. In either case, all items shall be fabricated to the sizes, dimensions, and shapes indicated on the drawings. Elbows shall be long radius, with the centerline to face dimensions equal to 1.5 times the pipe diameter unless otherwise indicated.

The ratio of pipe diameter to wall thickness shall not exceed 200. Unless otherwise indicated in the Light Wall Steel Pipe Schedule 15063-S01, the wall thickness shall be not less than 0.134 inch (10 gage) (3.42 mm).

Specified nominal pipe size for 14 inch (350 mm) and larger pipe, fittings, and specials shall be the actual outside diameter, in inches (mm).

The outside diameter of 12 inch (300 mm) and smaller pipe shall conform to the dimensions set forth in ANSI/ASME B36.10 for standard weight steel pipe.

Bends, fittings, branch connections, and special sections shall be reinforced or shall have their shell thickness increased so that the combined stresses due to internal pressure and bending will not exceed 50 percent of the yield strength of the material. Contractor shall determine and provide reinforcements or additional shell thickness as needed to keep the combined stresses within the specified maximum. Unless otherwise indicated on the drawings or directed, the internal working pressure for design purposes shall be as indicated in the Light Wall Steel Pipe Schedule 15063-S01. The dead load shall be equal to the weight of the pipe.

2.2 MATERIALS. Unless otherwise required by the drawings, field joints shall be either flanged or mechanically coupled.

Pipe	ANSI/AWWA C200, ASTM A139.
Fittings and Specials	ANSI/AWWA C200.
Dimensions	AWWA C208.
Flanged Joints	
Flanges	Flat faced when connecting to flat faced flanges; otherwise, raised face. Steel plate of the following thickness:

Nominal Pipe Size inches [mm]	Flange Thickness inches [mm]
6 [150]	1/4 [6]
8,10 [200, 250]	5/16 [7.8]
12 [300]	3/8 [9.3]
14-20 [350 - 500]	7/16 [10.9]
24 [600]	1/2 [12.7]
30, 36 [750, 900]	5/8 [15.6]
42, 48 [1200]	3/4 [19]

Material	ASTM A36.
Diameter and Drilling	ANSI/ASME B16.1, Class 25.

Flange Bolting

Material	ASTM A307.
Type	Bolt and nut; bolt-stud and two nuts permitted for 1 inch and larger.
Bolts and Bolt-Studs	
Length	Such that ends project 1/4 to 1/2 inch [6 to 12.7 mm] beyond surface of nuts.
Ends	Chamfered or rounded.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2A fit. Bolt-studs may be threaded full length. Studs for tapped holes shall be threaded to match threading in holes.
Bolt Heads	
Shape	Hexagonal or square.
Dimensions	ANSI/ASME B18.2.2; regular pattern for square, heavy pattern for hexagonal.
Nuts	Hexagonal.
Dimensions	ANSI/ASME B18.2.2, heavy, semifinished pattern.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2B fit.

Gaskets

For Aeration/Backwash Air Service

Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact fact, 1/16 inch [1 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces, rated for 275°F [135°C] service; Garlock "IFG 5507".

Flat Faced Flanges	Premium Grade, EPDM, ring type, 1/8 inch (3 mm) thick, rated for 275°F (135°C) service, Garlock "8314".
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Coupled Joints	
Mechanical Couplings	Dresser "Style 38 Light Pattern Couplings" or Smith-Blair "411 Flexible Coupling", without pipe stop. Elastomers for air piping shall be rated at 275°F (135°C).
Joint Harness	
Bolts	ASTM A193, Grade B7, or Ryerson "Stress-Proof". Minimum yield point 100,000 psi (689 Mpa).
Threading	ANSI/ASME B1.1, Class 2A fit, coarse thread series.
Ends	Chamfered or rounded.
Nuts	Hexagonal, ASTM A307.
Threading	As specified for bolts except Class 2B fit.
Dimensions	ANSI/ASME B18.2.2, heavy, semifinished pattern.
Flat Washers	Steel, ANSI B18.22.1.
Grooved Couplings	ANSI/AWWA C606, Gustin-Bacon "Gruvagrip Series 100" or Victaulic "Style 77", as needed.
Small Branch Connections	

Pipe Nipples	Seamless black steel pipe, ASTM A53, standard weight (Schedule 40).
Welding Fittings	
Threaded Outlets	Bonney "Thredolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Welded Outlets	Bonney "Weldolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Expansion Joints	Mercer "Style 450N" or Redflex "No. J-1", single arch, spool type with elastomeric body rated for 300°F [149°C], split steel retaining rings, and control rods, unless otherwise indicated.
Watertight/Dusttight Pipe Sleeves and Sealing Elements	O-Z Electrical Manufacturing "Thruwall" and Floor Seals",or Thunderline Corporation "Link-Seal", with modular rubber sealing elements with galvanized bolts.
Pipe Sleeve Sealant	Polysulfide or urethane, as specified in Master Specification Section 07600, Caulking and Sealers.
Insulation	
Hot Pipe	ASTM C547, Class 1 (to 450 F), 1 inch (25 mm) thick; glass fiber, one-piece molded with vapor barrier, flame-retardant all service jacket and self-sealing tabs; CertainTeed "500 Snap-On" or Owens-Corning "Fiberglas 25 ASJ/SSL".
Jacket	Aluminum, ASTM B209, Alclad 3004, 0.020 inch (0.051 mm) thick, machine rolled, with asphalt and kraft paper vapor barrier.
Cold Piping	Fed Spec HH-I-573, tubular, closed cell elastomeric, at least 3/4 inch (19 mm) thick.
Fittings, Flanges, and	ASTM C547, Class 1 (to 450°F (232°C)),

Valves	1 inch (25 mm) thick, factory molded glass fiber fitting insulation; CertainTeed "Snap Form" or Poncho "Poncho Preformed".
Anchor Bolts	Carbon steel, as specified in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

2.3 ENDS OF SECTIONS.

2.3.01 For Field Welding. Ends of pipe, fittings, and specials for field butt welding shall be outside beveled to an angle of 35 degrees, plus or minus 2-1/2 degrees, with the plane of the pipe end, with an average flat at the end of the pipe of 1/16 inch (1.5 mm) plus or minus 1/32 inch (0.75 mm).

2.3.02 For Fitting with Flanges. Ends to be fitted with flanges shall have the longitudinal or spiral welds ground flush as needed to accommodate the type of flanges provided.

2.3.03 For Mechanical Couplings. Ends to be joined by mechanical couplings shall be plain end type. In addition, the welds on ends to be joined by couplings without pipe stops shall be ground flush to permit slipping the coupling in at least one direction to clear the pipe joint. Outside diameter and out-of-round tolerances shall be within the limits specified by the coupling manufacturer.

2.3.04 For Grooved Couplings. Ends to be joined by grooved couplings shall be of the roll grooved type as recommended by the coupling manufacturer.

2.4 PIPE LENGTH TOLERANCE. Standard and special sections shall be within 1/8 inch (plus or minus) of the specified or theoretical lengths. All pipe to be connected with mechanical couplings shall be fabricated so that space between pipe ends within the couplings will not exceed the allowable, as recommended by the coupling manufacturer, but will be at least 1/8 inch (3 mm).

2.5 SPECIAL SECTIONS. All fittings and specials shall be provided with ends as specified, and shall be fabricated to the shapes, sizes, and dimensions indicated on the drawings.

2.6 SMALL BRANCH CONNECTIONS. Small branch connections 2 inches and smaller shall be made using welding fittings with threaded outlets. Where there is some doubt as to the exact outlet size required, but it is known that the size will be less than 1 inch, a 1 inch (25 mm) outlet shall be provided, and reducers used as needed.

Branch connections 2-1/2 inches (63 mm) and larger shall be made using pipe nipples or welding fittings. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as required to meet design and test requirements.

Small branch connections shall be located so as not to interfere with joints, supports, or other details.

2.7 DRAINS. Drains shall be provided at the locations indicated on the drawings. Drain valves shall be hose gate valves. Drain valves shall comply with the requirements of the Master Specification Section 15100, Miscellaneous Valves.

Pipe used for drain piping shall be standard weight, galvanized steel pipe.

2.8 FIELD JOINTS. Flanged, welded, and mechanically coupled joints shall be provided at the locations indicated on the drawings. To facilitate installation, additional field welded and mechanically coupled joints may be provided when required. These field joints shall be kept to a minimum, and their location shall be acceptable to Engineer.

2.9 FLANGED JOINTS. Flanged joint faces shall be normal to the pipe axis, with a maximum tolerance of 0.005 inch per foot (0.125 mm/300 mm) of flange diameter. Angular deflection (or layback) of the flange face shall not exceed 0.75 degree from a plane surface and shall be uniform within 0.010 inch (2.5 mm). All flanges, after welding to the pipe, shall be measured and shall be refaced, if necessary, to bring them within the specified tolerances.

Contractor shall coordinate diameter and drilling of flanges furnished in the piping with the flanges for any valves, blowers, vacuum pumps, and other equipment to be installed in the piping.

Blind flanges shall conform in diameter, drilling, and thickness to the flanges to which they attach and shall be reinforced as needed to produce an airtight joint.

2.10 MECHANICAL COUPLINGS.

2.10.01 Couplings. Unless otherwise shown on the drawings, the middle ring of each mechanical couplings shall have a thickness at least equal to that specified for the size pipe on which the coupling is to be used and shall be not less than 7 inches (175 mm) long. The pipe stop shall be omitted from the inner surface of the middle rings of all couplings. The couplings shall be cleaned and shop primed with the manufacturer's standard universal primer.

2.10.02 Joint Harnesses. Where noted or indicated on the drawings, mechanically coupled joints shall be restrained with harness bolts and lugs. Joint harnesses shall conform to the details on the drawings. Lugs shall be shop welded to the pipe and coated as specified for the adjacent pipe.

2.10.03 Grooved Couplings. Grooved couplings shall be sized for proper installation on the grooved pipe provided.

After fabrication, all housing clamps forming the coupling shall be cleaned and primed by the coupling manufacturer as specified for the pipe.

2.11 WELDED JOINTS. All welds shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be airtight. Butt welds shall be used for all welded joints in line pipe assemblies and in the fabrication of bends and other specials. Fillet welds shall be used for flange attachment. Welding of field joints shall conform to ANSI/AWWA C206.

2.12 PIPE SUPPORTS, ANCHORS, AND HANGERS. Pipe supports, anchors, and hangers shall be fabricated in accordance with the requirements of Master Specification Section 15140, Pipe Supports, or the details indicated on the drawings. Pipe supports, anchors, and hangers shall be furnished and installed complete with all concrete bases, anchor bolts and nuts, plates, rods, and other accessories required for proper installation. Where the details must be modified to fit the piping and structures, all such modifications shall be subject to review and acceptance by Engineer. Lugs required for lateral or longitudinal anchorage shall be shop welded to the pipe.

2.13 PIPE SLEEVES. Piping passing through concrete or masonry shall be installed through sleeves installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors provided with a special finish, such as ceramic or vinyl-composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. In all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch (25 mm) nor more than 2 inches (50 mm) above the floor surface, with the projection uniform in each floor area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the drawings indicate future installation of pipe, sleeves shall be provided and the ends sealed with suitable plastic caps or plugs.

Holes drilled with a suitable rotary drill will be considered in lieu of sleeves for piping which passes through interior walls and through floors having a special finish.

Unless otherwise indicated on the drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

Piping passing through walls and floors shall be made dusttight and gastight when specified herein, with special rubber-gasketed sleeve and joint assemblies, with sleeves sealed with modular rubber sealing elements, or by caulking with oakum and sealing each end with polysulfide or urethane sealant.

2.14 PROTECTIVE COATINGS. All steel pipe, fittings, specials, and wall fittings shall be prepared and prime coated as specified herein.

2.14.01 Type of Coating. The type of protective coating to be used shall be as follows:

Exterior Surfaces in Interior and Exterior Locations. Exterior surfaces, except machined surfaces, of all pipe, fittings, specials, flanges, anchors, and pipe supports exposed in interior locations and in manholes shall be thoroughly blast cleaned and given a coat of universal primer.

Field painting shall be as specified in the Master Specification Section 9900, Painting.

Interior Surfaces. The interior surfaces of all steel pipe, fittings, and specials shall not be coated.

Machined Surfaces. All machined surfaces shall be shop coated with rust-preventive compound.

2.15 INSULATION. The following systems shall be insulated:

Hot piping	Explosed blower discharge piping less than 8 feet (2.4 m) above finished floor or grade.
Cold Piping	Blower suction piping.

2.16 INSPECTION AND TESTING. Inspection and testing by an independent laboratory will not be required at the fabricating or coating shop; however, the pipe manufacturer shall furnish an affidavit of compliance certifying that all materials used and work performed comply with the specified requirements. Seven copies of the affidavit shall be furnished.

PART 3 - EXECUTION

3.1 INSTALLATION. All piping shall be installed in the location and arrangement indicated on the drawings.

Taps for pressure gauge connections on the suction and discharge of blowers shall be provided with a nipple and a ball type shutoff valve.

Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

3.1.01 Concrete. Concrete reaction anchorage and supports shall be provided where and as indicated on the drawings.

3.1.02 Flanged Joints. Care shall be taken in bolting flanged joints so that there is no restraint on the opposite end of the piece which would prevent pressure from being evenly and uniformly applied to the gasket. The pipe or fitting must be free to move in any direction during installation of bolts. Bolts shall be gradually tightened, each in turn, at a uniform rate of gasket compression around the entire flange.

Special care shall be taken when connecting to equipment to ensure that piping stresses are not transmitted to the equipment flanges by the connected piping. All such piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before installation of any bolts in those flanges. In addition, equipment connection piping shall be free to move parallel to its longitudinal center line while the bolts are tightened. Equipment shall be leveled, aligned, and wedged in position to fit the connecting piping. Equipment shall not be grouted until the initial fitting and alignment of the pipe so that the equipment may be shifted on its foundation if necessary to properly install the connecting piping. Each piece of equipment shall be grouted before final bolting of the connecting piping. After final alignment and bolting, the equipment connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the equipment or opening of the equipment connection joints.

3.1.03 Couplings. The ends of the pipe on which couplings are to be placed, and the couplings themselves, shall be clean and free from any dirt or foreign material, especially those surfaces of the pipe and coupling that contact the gaskets. Gaskets shall be kept clean with no foreign matter between them and the packing surfaces. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. All bolts shall be tightened approximately the same amount, with all parts of the coupling square and symmetrical with the pipe. After installation, couplings shall be carefully touched up or reprimed.

3.1.04 Insulation. Pipe insulation shall be provided where indicated on the drawing and shall be neatly installed in accordance with the manufacturer's recommendations. Piping shall be clean and dry and shall have been tested, when testing is required, before insulation is applied.

End and longitudinal joints shall be tightly butted and sealed with lap and butt strips of self-sealing jacket material.

Fittings, flanges, and valves shall be insulated with molded insulation and all service, one-piece jackets installed in accordance with the manufacturer's recommendations. Fitting insulation shall overlap adjacent pipe insulation at least 1 inch (25 mm). Valves shall be insulated up to the gland only.

Pipe hangers shall permit insulation to pass through and suitable saddles shall be provided to prevent the weight of the piping from being supported by the insulation.

3.2 CLEANING. All pipelines shall be clean and free of dirt, rocks, debris, or other foreign material of any kind when placed in service.

The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted.

3.3 PRESSURE AND LEAKAGE TESTING. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction, of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation. Air piping shall be tested using compressed air.

Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing.

All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor and at the time directed by Engineer.

All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

End of Section

SECTION 15064

STAINLESS STEEL PIPE, TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of stainless steel pipe, tubing and accessories for the services as indicated in the Contract Documents. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Flange gaskets.

Insulating couplings.

Pipe sleeves.

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Stainless steel pipe materials shall be as indicated.

Material Classification	SS-1
Schedule 10S Stainless Steel With Buttwelded Fittings	
Pipe	ASTM A312, Grade TP304L
Fittings	ASTM A774, wrought stainless steel, grade equivalent to pipe, with beveled ends and Schedule 10S wall thickness.
Material Classification	SS-2
Schedule 10S Stainless Steel With Flanged Fittings	
Pipe	ASTM A312 or ASTM A778, Grade TP304L or TP316L.
Fittings	ASTM A774, wrought stainless steel, grade equivalent to pipe, with angle face rings and stainless steel backing flanges.
Material Classification	SS-3
Schedule 40S Stainless Steel With Threaded Fittings	
Pipe	ASTM A312, Grade TP304 or TP316.
Fittings	AISI Type 304 or 316 to match pipe, Class 150, dimensions conforming to ANSI/ASME B16.3.

Material Classification	SS-4
Schedule 40S Stainless Steel With Socket Welded Fittings	
Pipe	ASTM A312, Grade TP304L or TP316L.
Fittings	ASTM A182, F304L or F316L to match pipe, and ANSI B16.11, Class 3000.
Material Classification	SS-5
Schedule 40S Stainless Steel With Buttwelded Fittings	
Pipe	ASTM A312, Grade TP304L or TP316L.
Fittings	ASTM A403, WP304L or WP316L to match pipe, and ANSI/ASME B16.9, Schedule 40S.
Material Classification	SS-6
Stainless Steel Tubing With Compression Fittings	
Tubing	ASTM A269, seamless, Grade TP304 or TP316, annealed, max hardness Rockwell B80; with the following min wall thicknesses:

Tube OD inches (mm)	Wall Thickness inches (mm)
1/4 to 3/8 (6 to 9)	0.065 (1.65)
1/2 to 7/8 (13 to 22)	0.083 (2.11)
1 to 2 (25 to 50)	0.109 (2.77)

Fittings	Compression type, AISI Type 316 stainless steel; Crawford "Swagelok", or Parker Hannifin "CPI" or "Ferulok".
Material Classification	SS-7

Schedule 10S Stainless Steel
With Buttwelded Fittings

Pipe	ASTM A312, Grade TP304L.
Buttwelded Fittings	ASTM A403, WP304L, and ANSI B16.9, Schedule 10S.

2.1.02 Accessory Materials. Accessory materials for the stainless steel pipe systems shall be as indicated.

Material Classification SS-1 and SS-2

Backing Flanges: Stainless steel plate, AISI Type 304 or 316 to match fittings, with ANSI/ASME B16.5, Class 150 diameter and drilling; with the following thicknesses:

Nominal Pipe Size inches (mm)	Flange Thickness inches (mm)
1/2-8 (13-200)	1/2 (13)
10-14 (250-350)	5/8 (16)
16-18 (400-450)	3/4 (19)
20-30 (500-750)	1 (25)
36 (900)	1-1/4 (32)

Flange Bolts and Nuts: ASTM A307, galvanized, length such that, after installation, bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of nut.

Flange Gaskets: Flexitalic "Style CG", spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch (5 mm) nominal thickness, with compression ring 1/8 inch (3 mm) thick to match required flange dimensions.

Material Classification SS-7

Flanges	ANSI B16.5, Class150, flat face, AISI Type 304.
Flange Bolts	ASTM A193, AISI Type 304, ANSI B18.2.1 heavy hex head, length such that, after installation, bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of nut.
Nuts	ASTM A194, AISI Type 304, ANSI B18.2.2 heavy hex pattern.
Flange Gaskets	Flexitalic "Style CG", spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch (5 mm) nominal thickness, with compression ring 1/8 inch (3 mm) thick to match required flange dimensions.
Material Classification	SS-3, SS-4, and SS-5
Flanges	ANSI/ASME B16.5, Class 150, flat faced, AISI Type 304, 304L, 316, or 316L, to match piping.
Flange Bolts	ASTM A193, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
Flange Nuts	ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch (3 mm) thick.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation .

3.2 LEAKAGE AND PRESSURE TESTS. After installation, stainless steel piping shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All stainless steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15065

MISCELLANEOUS STEEL PIPE, TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that is less than 24 inches (600 mm) in diameter for the services as specified herein. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Expansion joints.

Flange gaskets.

Glass lined pipe and fittings.

Grooved and mechanical couplings.

Insulating (dielectric) couplings, threaded and flanged.

Name of Manufacturer.

Type and Model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

1.4.01 Coated Pipe. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Miscellaneous steel pipe materials shall be as indicated.

Material Classification	CSG-1
Standard Weight Galvanized Steel With Threaded Cast Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness.
Fittings	Threaded type, ANSI/ASME B16.4, Class 125.
Material Classification	CSG-2
Standard Weight Galvanized Steel With Threaded Malleable Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness.

Fittings	Threaded type, ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type II.
Material Classification	CSG-3
Standard Weight Galvanized Steel With Flanged Cast Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness.
Fittings	Flanged type, ANSI/ASME B16.1, Class 125.
Material Classification	CS-1
Standard Weight Steel With Threaded Malleable Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type I.
Material Classificaion	CS-2
Standard Weight Steel With Forged Steel Socket Welded Fittings	
Pipe	ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.
Material Classification	CS-3
Standard Weight Steel With Buttwelded Fittings	

Pipe	ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI/ASME B16.9; standard weight.
Material Classification	CS-4
Extra Strong Steel With Forged Steel Threaded Fittings	
Pipe	ASTM A53, Type S, extra strong, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI B16.11, Class 2000 or 3000; Bonney, Crane, Ladish, or Vogt.
Material Classification	CS-5
Extra Strong Steel With Forged Steel Socket Welded Fittings	
Pipe	ASTM A53, Type S, extra strong, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.
Material Classification	CS-6
Extra Strong Steel With Buttwelded Fittings	
Pipe	ASTM A53, Type E, extra strong, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI/ASME B16.9; extra strong.
Material Classification	CS-7
Standard Weight Steel With Threaded Cast Iron Fittings	

Pipe	ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	Threaded type, ANSI/ASME B16.4, Class 125. When used for lime slurry piping service, fittings and flanges for disassembly and cleaning shall be provided only at the locations indicated on the drawings. Changes in alignment at other locations shall be accomplished by bending the pipe. All bends shall have a radius of at least 3 feet [0.9 m].
Material Classification	CS-8
Steel Hydraulic Tubing With Compression Fittings	
Tubing	ASTM A179, seamless, soft annealed, wall thickness as required.
Fittings	Steel, compression type, Crawford "Swagelok" or Parker Hannifin "CPI".
Material Classification	CS-9
PP Lined Steel Pipe	
Pipe and Lining	ASTM F429.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-10
PVD Lined Steel Pipe	
Pipe and Lining	ASTM F491.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-11
FEP Lined Steel Pipe	

Pipe and Lining	ASTM F546.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-12
PTFE Lined Steel Pipe	
Pipe and Lining	ASTM F423.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-13
Glass Lined Steel Pipe	
Pipe	Standard weight steel pipe with flanged ends and Ceramic Coating "Non-Stick Glass Lining" or Vitco "SG-14 Glass Lined Pipe".
Fittings	Ductile iron, as specified in Master Specification Section 15061, Ductile Iron Pipe, with Ceramic Coating "Non-Stick Glass Lining" or Vitco "SG-14 Glass Lined Pipe".
Material Classification	CS-14
Double-Wall Secondary Containment Pipe	Perma Pipe/Ricwil Type "Ultra FS".
Carrier Pipe	Black steel pipe, ASTM A53, Type S, Grade B, Schedule 80.
Containment Pipe	Black steel pipe, ASTM A53, Type S, Grade B, Schedule 40 with FRP filament wound outer covering bonded to steel containment pipe, minimum 0.100 inch [2.5 mm] thick.
Fittings	Factory prefabricated, of the same materials and thickness as the specified pipe.

Leak Detection	Stainless steel leak detection guide tube and stainless steel cable pull wire to allow pulling of the leak detection cable into the containment pipe, both during and after piping installation.

2.1.02 Accessory Materials. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Nipples	ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.
Unions (Malleable Iron)	Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.
Flanges	
For Standard Weight Pipe	ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.
For Extra Strong Pipe	
Chemical Gas Piping	ASTM A105, forged steel, tongue and groove flanged union type, with nonmetallic gasket; rated for a working pressure of 1,500 psi [10.3 MPa].
Digester Gas Piping	ANSI/ASME B16.5, Class 150, flat faced.
Other Services	ANSI/ASME B16.5, Class 300, raised face.
For Plastic Lined Pipe	Steel, forged or cast, diameter and drilling in accordance with ANSI/ASME B16.5, Class 150 or 300 as required.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.

Flange Gaskets

For Aeration/Backwash Air Service

Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch [1.5 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces, rated for 275°F [135°C] service; Garlock "IFG 5507".
Flat Faced Flanges	Premium Grade, EPDM, ring type, 1/8 inch (3 mm) thick, rated for 275°F (135°C) service; Garlock "8314".

For Boiler Exhaust Service	Garlock "Blue-Gard, Style 3000".
For Oil Service	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch (1.5 mm) minimum thickness for plain finished surfaces, 3/32 inch (2 mm) minimum thickness for serrated surfaces.
For Heating Water Service	Non-asbestos inorganic fiber with nitrile binder; dimensions to suit flange contact face, 1/16 inch (1.5 mm)minimum thickness for plain finished surfaces, 3/32 inch (2 mm) minimum thickness for serrated surfaces; Garlock "IFG 5500".
For Water Service	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch (3 mm) thick.

For Other Services

Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch (1.5 mm) minimum thickness for plain finished surfaces, 3/32 inch (2 mm) minimum thickness for serrated surfaces.

Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non- asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch +/- 0.005 inch (2.4 mm +/- 0.13 mm).
Grooved Couplings	
Rigid	AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
Standard	AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 77".
Mechanical Couplings	Dresser "Style 38" or Smith-Blair "Type 411 Flexible Coupling"; without pipe stop.
Expansion Joints	Flexonics "Model H Expansion Compensators" for 3 inch (75 mm) or smaller; Flexonics "Free Flexing Expansion Joints" with flanged ends and stainless steel bellows for 4 inch (100 mm) or larger.
Material Classification	CS-11
Joining	Carrier pipe shall be joined by socket welding. Containment pipe shall be joined by split sleeve of the same diameter as containment pipe with minimum 60 mil (1.5 mm) thick polyethylene jacket.
End Seal	End seals shall be furnished at all terminal ends. The end seal shall be sealed to the containment pipe.
Leak Detection	Microprocessor based monitoring unit, for continuous monitoring by cable of a single line for water and hydrocarbon.
Control Panel	Modified NEMA Type 12 enclosure, with status and alarm data Model "PAL-AT20C". Power supply to the unit will

	be 120 volt, 1 phase, 60 Hz. Unit shall be UL listed with alarm horn and shall locate leaks and not depend on battery back-up functions. System conditions shall be stored in memory in the event of power failure and shall automatically resume monitoring without reset once power is available. Monitoring unit shall be able to differentiate between water left in pipe during installation and an actual growing leak. Panel shall also be able to detect a break in sensor cable and its location.
Cable	Cable shall be located in the interstitial space between the carrier and containment pipe, shall detect both water and hydrocarbon, and shall be capable of being dried in place without being replaced after exposure to any fluid Type "AGW-Gold". Coaxial cable shall interface monitoring control panel with sensor cable by utilizing waterproof junction box for protecting connection.

2.1.03 Coatings and Linings. Standard weight steel pipe in buried locations shall have exterior surfaces protected with a shop applied plastic coating.

Extra strong steel pipe in buried locations shall have exterior surfaces protected with a shop applied plastic coating, a shop applied tape wrap, or will be coated by others in the field.

All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils (1.5 mm).

Coatings and linings shall be as indicated.

External Coatings

Plastic	Chevron Chemical Co. "Plexco Plexguard Coating" or Encoat/Lukens "Encoat Extruded Coating". The

	products of other manufacturers will not be acceptable.
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils (760 µm); Protecto Wrap "200" or Tapecoat "CT".
Internal Linings	
PP Lining	ASTM F492.
PVDF Lining	ASTM F491.
FEP Lining	ASTM F546.
PTFE Lining	ASTM F423.
Glass Lining	Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 8 mils (200 µm), Mohs' Hardness 5 to 6, density 2500 to 3000 kg/m^3 as determined by ASTM D792.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation .

3.2 LEAKAGE AND PRESSURE TESTS. After installation, steel piping shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15066

FIBERGLASS REINFORCED PLASTIC PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installation of low pressure fiberglass reinforced plastic pipe for exhaust air systems as indicated in the Contract Documents. Piping shall furnished complete with all fittings, transitions, jointing materials, expansion joints, and other necessary appurtenances.

Pipe supports are covered in Master Specification Section 15140, Pipe Supports. Anchors are covered in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

Pipe trenching, bedding, and backfill are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

1.2 GENERAL.

1.2.01 Coordination. Contractor shall verify that each component of the system furnished is compatible with all other parts of the system, that all piping and materials are appropriate for the expected services, and that all devices necessary for a properly functioning system have been provided.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.2.03 Pipe Identification. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data and catalog cuts, and shop assembled layout drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications shall include, but shall not be limited to, the following:

Pipe

Manufacturer’s name.

Brand designation.

Type of resin.

Pressure, vacuum, and temperature rating of pipe.

Certification of compliance with referenced standards.

Layouts and dimensions of subassemblies to be shipped.

Where the pipe sizes needed for the project are larger than the named manufacturer's standard pipe sizes, the following information shall be submitted for the pipe and fittings that are being provided:

Manufacturer's name.

Certified statement that covers construction and test methods.

Material sources.

Material types.

Average reinforced wall thickness for each pipe size.

Minimum reinforced wall thickness for each pipe size.

Average outside diameter for each pipe size.

Liner material.

Nominal liner thickness for each pipe size.

Expansion Joints

Name of manufacturer.

Type and model.

Materials of construction.

Force required for expansion and contraction.

Contractor shall submit procedures and results of all shop and field testing.

1.4 QUALITY ASSURANCE.

1.4.01 Manufacturer's Field Services. When indicated in the Contract Documents, the pipe manufacturer shall provide hands-on training for the installation contractor's employees in the proper assembly of butt joints. The pipe manufacturer's representative shall be on-site for at least one 8-hour day, during which they shall observe the assembly of at least three butt joints. The pipe manufacturer shall provide hands-on training for the installation contractor's employees in the proper assembly of butt joints. The pipe manufacturer shall submit written certification that the installation contractor's employees have satisfactorily completed all training and instruction and can perform the jointing required for this project in accordance with the pipe manufacturer's recommendations and as specified herein. All field butt joints shall be made by representatives of the pipe manufacturer or by employees of the installation contractor who have been trained and certified by the pipe manufacturer.

All fitters who fabricate and install piping with butt joints shall be qualified for this project. Training and qualification shall be provided by an authorized representative of the pipe manufacturer. Qualified fitters shall carry and have visible at all times a certificate of qualification issued by the pipe manufacturer. Contractor shall arrange the qualifying training.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Pipe and fittings shall be properly supported to avoid damage caused by flexural strains. Pipe and fittings shall not be thrown or dropped.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Fiberglass reinforced pipe will be used in the service conditions as indicated in the Contract Documents.

Pipe and appurtenances used in ventilation exhaust air or odor control systems will be continuously exposed to a humid environment containing hydrogen sulfide gas. Pipe and appurtenances used in emergency gas treatment exhaust systems will be exposed to chlorine gas.

2.2 DESIGN REQUIREMENTS.

2.2.01 Minimum Pipe Wall Stiffness. The minimum pipe wall stiffness, at 5 percent deflection, determined in accordance with ASTM D2412 and Section 3 of AWWA C950, shall be not less than the following:

Nominal Pipe Diameter		Pipe Stiffness	
inches	(mm)	psi	(kPa)
1-8	(25-200)	36	(250)

10	(250)	18	(125)
12-16	(300-400)	9	(62)
18 and larger, buried	(450 and larger, buried)	10 or greater as required	(70)
18 and larger, other locations	(450 and larger, other locations)	5	(35)

2.2.02 Temperature. All pipe, fittings, and appurtenances shall be suitable for the temperature conditions as indicated in the Contract Documents.

2.2 ACCEPTABLE MANUFACTURERS. The fiberglass reinforced plastic pipe, fittings and specials provided under this section shall be from the manufacturer as specified herein without exception.

2.3 MATERIALS.

Epoxy Pipe

Centrifugally Cast, 14 inches (350 mm) and smaller	ASTM D2997, RTRP-21C, centrifugally cast, reinforced epoxy resin pipe with 30 mil (750 µm) liner; Fibercast "Centricast III EP"; without exception.

Filament-Wound

16 inches (400 mm) and smaller	ASTM D2996, RTRP-11FE-111, RTRP-11FF-312, and RTRP-11FQ-311, with at least a 20 mil (500 µm) reinforced liner; Ameron "Bondstrand Series 2000"; Conley "Schedule 20E"; or Smith Fiberglass Products "Green Thread"; without exception.
18 through 20 inches (450 through 500 mm)	ASTM D2310, RTRP-11FQ, with at least a 20 mil (500 µm) reinforced liner; Conley "Schedule 20E"; without exception.

Vinyl Ester Pipe

16 inches (400 mm) and smaller	ASTM D2996, RTRP-12ED-101, RTRP-12EF-311, RTRP-12EQ-311, or RTRP-12EU-311, with vinyl ester resin and at least a 20 mil (500 µm) reinforced liner;

	Ameron "Bondstrand Series 5000"; Conley "Schedule 20V"; Fibercast "F-Chem 1222" or "F-Chem-V"; or Smith Fiberglass Products "Poly Thread"; without exception.
18 inches (450 mm) and larger	ASTM D2310, RTRP-12ED, -11EQ, or -12EU, with vinyl ester resin and at least a 20 mil (500 µm) reinforced liner; Ameron "Bondstran Series 5000"; Conley "Schedule 20V"; Fibercast "F-Chem-V"; or Smith Fiberglass Products "Big Thread LVV"; without exception.
Fittings	Manufacturer's standard, glass fiber reinforced, compatible with the pipe and with chemical resistance equal to or greater than the pipe.
Flanges	ASTM D3982
Flange Bolts or Studs	ASTM A307, Grade B, galvanized or ASTM F593, Type 304 stainless steel as required; length such that, after installation, bolts will project 1/8 to 3/8 inch (3 to 9 mm) beyond the outer face of the nut.
Nuts	ASTM A307, Grade B, galvanized or ASTM F594, Type 304 stainless steel.
Flat Washers	ANSI B18.22.1, plain, galvanized or ANSI B18.22.1, Type 304 stainless steel.
Flange Gaskets	Full face, ASTM D2240, Type A durometer 50-70; at least 1/8 inch (3 mm) thick, neoprene, viton, or nitrile material.
Bell-and-Spigot Joints	Matched tapered bell-and-spigot ends bonded with adhesive.
Butt Joints	Butt and wrap, resin bonded, PS-15, with pressure rating equal to the pipe.
Expansion Joints	As specified herein.
Adhesive	Pipe manufacturer's standard.

All pipe, fittings and appurtenances shall contain ultraviolet (UV) inhibitors. Resins used in the piping system laminates shall have a flame spread rating of 25 or less when tested in accordance with ASTM E84.

2.4 FABRICATION.

2.4.01 Jointing Method. Unless otherwise specified, 14 inch (350 mm) and smaller pipe shall have coupled adhesive bonded joints. Sixteen inch (400 mm) and larger pipe shall have bell-and-spigot or butt joints. Shop fabricated assemblies should be provided to the maximum extent possible, to minimize the number of field joints.

Flanged joints shall be provided at each damper and item of equipment to facilitate disassembly, at each change in material, and where indicated on the drawings. Bolts, nuts, washers, and gaskets shall be provided for all flanged connections in the piping system, including connections to equipment.

Field butt joints shall be located at least 12 inches (300 mm) from any increasing or decreasing cross-section of pipe where the pipe to be jointed has the same diameter.

2.4.02 Butt Joints. Butt joints shall be provided in accordance with the manufacturer's recommendations and as specified herein. Twenty inch (500 mm) and larger pipe shall be overlaid both inside (when accessible) and outside. Eighteen inch (450 mm) and smaller pipe shall be overlaid on the outside only. The minimum width of the overlay shall be as specified in the following table. Inside overlaps shall be made to seal the joint but shall not be considered in meeting the strength requirements.

Pipe Size		Minimum Total Width of Overlay	
Inches	(mm)	Inches	(mm)
18-20	(450-500)	14	(350)
24-36	(600-900)	18	(450)
42-54	(1050-1350)	24	(600)
60-72	(1500-1825)	26	(650)

Finished joints shall be built up in successive layers, shall be as strong as the pieces being joined, and shall be as crevice-free as is commercially practicable, in accordance with ASTM D2563. The width of the first layer shall be at least 4 inches (100 mm). Successive layers shall be increased uniformly to provide the specified minimum total width of overlay which shall be centered on the joint. Crevices between jointed pieces shall be filled with resin, leaving a smooth inner surface. The interior of joints shall also be sealed by covering with not less than 0.1 inch (2 mm) of liner of the same material as the pipe.

2.4.03 Transitions. Fiberglass reinforced plastic transition sections shall be furnished for connecting round pipe to rectangular openings on equipment. Transitions shall have a pressure rating and wall stiffness equal to those of the pipe. Internal lining shall be of the same type of material and thickness as specified for the pipe. Transitions shall have flanged end connections compatible with the connecting pipe and equipment.

2.4.04 Expansion Joints. Expansion joints shall be furnished at the locations indicated on the drawings and at other locations required for proper pipe installation. Expansion joints shall be resistant to ultraviolet light and shall be suitable for the service conditions.

Expansion joints shall be slip-on or flange type. The slip-on type shall be sized to fit tightly on the outside circumference of the pipe and shall be secured in place by adjustable, corrosion-resistant band type clamps. Flange type expansion joints shall have split steel retaining rings and shall have diameter and drilling to match the pipe flanges.

Expansion joints shall be designed to compress 1 inch (25 mm) and to elongate 1 inch (25 mm) with a maximum force to cause movement of 100 lbs (445 N) or less. The joints shall also allow lateral deflections of up to 1 inch (25 mm).

PART 3 - EXECUTION

3.1 INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Any pipe that is damaged or shows evidence of contamination shall not be installed in the piping system.

3.2 PREPARATION.

3.2.01 Field Measurement. Pipe shall be cut to measurements taken at the site, not from the drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION. Pipe shall be installed as specified and as indicated on the drawings. All necessary provisions shall be taken in the fabrication and installation of piping to provide for expansion and contraction. Expansion joints shall be installed.

The piping shall be supported as indicated on the drawings and in accordance with the requirements of Master Specification Section 15140, Pipe Supports.

The inside of pipe, fittings, and transitions shall be smooth, clean, and free from blisters, when installed.

3.3.01 Pipe Sleeves. Piping passing through concrete or masonry shall be installed through sleeves installed before the concrete is placed or when masonry is laid.

3.3.02 Pipe Joints. Pipe joints shall be carefully and neatly made in accordance with the following specified requirements.

3.3.02.01 Adhesive Bonded Joints. All joint preparation, cutting, and jointing for adhesive bonded joints shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the recommended curing period.

3.3.02.02 Flanged Joints. Flange bolts shall be tightened sufficiently to slightly compress the gasket and make a good seal, but not so tight as to distort the flanges. A flat washer shall be installed under each nut and bolt head.

3.3.02.03 Butt Joints. Butt joints shall be made in accordance with the manufacturer's recommendations and as specified herein.

The inner surface shall be free of cracks and crazing, with a smooth finish, and with an average of not more than two pits per square foot (21 pits per square meter), provided the pits are less than 1/8 inch (3 mm) in diameter, not more than 1/32 inch (0.7 mm) deep, and covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits. Such surfaces may be reinforced with glass surfacing mat, synthetic fibers, or other suitable material.

3.3.03 Alignment. Piping installed below grade shall be laid to the lines and grades indicated on the drawings. Batter boards, laser beam equipment, or surveying instruments shall be used to maintain alignment and grade.

Batter boards, if used, shall be erected at intervals of not more than 25 feet (7 m). Batter boards shall be used to determine and check pipe subgrades. At least three batter boards shall be maintained in proper position at all times when trench grading is in progress.

If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.3.04 Laying Pipe. Pipe installed below grade shall be protected from lateral displacement by placing the specified pipe embedment material. Pipe shall not be laid in water or under unsuitable weather or trench conditions.

Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Engineer.

Whenever pipe laying is stopped, the open end of the pipe shall be closed with an end board closely fitting the end of the pipe, to keep sand and earth out of the pipe. The end board shall have several small holes near the center to permit water to enter the pipe and to prevent flotation in the event of flooding of the trench.

3.4 FIELD QUALITY CONTROL.

3.4.01 Butt Joint Procedure Training. When training isindicated in the Contract Documents , the pipe manufacturer shall submit written certification that the installation contractor’s employees have satisfactorily completed all training and instruction and can perform the jointing required for this project in accordance with the pipe manufacturer’s recommendations and as specified herein.

3.4.02 Field Testing. All necessary testing equipment and materials, including tools, appliances, and devices, shall be furnished by Contractor. All tests shall be made by and at the expense of Contractor and at such time as directed by Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to demonstrate compliance with specified requirements. Engineer shall be present during all testing. The piping system shall be tested at 0.75 psi (5 kPa) pressure with air for at least 1 hour, and shall not leak. All joints which are found to leak, by observation or during testing, shall be repaired by Contractor, and tests repeated.

Leakage may be determined by loss of pressure or other method acceptable to Engineer. All equipment or other accessories which would be damaged if subjected to the specified test pressure shall be disconnected, and ends of branch lines plugged or capped, as required, during the testing procedures.

End of Section

SECTION 15067

MISCELLANEOUS PLASTIC PIPE, TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous plastic pipe, tubing and accessories for the services as indicated in the Contract Documents. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Chemical resistant waste pipe and fittings.

Expansion joints.

Flange gaskets.

FRP double wall pipe and fittings.

Gas pipe and fittings.

Pipe sleeves.

Polyethylene pipe and fittings.

Polypropylene pipe and fittings.

PVC pipe and fittings.

CPVC pipe and fittings.

PVDF pipe and fittings

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Pipe, tubing, and fittings shall be stored between 40°F and 90°F (4°C and 32°C).

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Miscellaneous plastic pipe materials shall be for the services as indicated in Miscellaneous Plastic Pipe, Tubing and Accessories Schedule 15067-S01.

Material Classification	FRP-1
FRP Pipe	
Pipe	ASTM D2996, filament-wound, glass fiber reinforced, vinyl ester resin pipe with 20 mil (500 μm) reinforced resin-rich liner; Fibercast "F-Chem 1222" or Smith Fiberglass Products "Poly Thread".
Fittings and Flanges	Glass fiber reinforced, compatible with the specified pipe, with ratings and chemical resistance equal to or greater than the specified pipe.

Material Classification	PVC-1
Schedule 40 PVC Pipe With Solvent Welded Joints	
Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Fittings	ASTM D2466, Cell Classification 12454-B, bearing NSF seal.
Material Classification	PVC-2
Schedule 80 PVC Pipe With Solvent Welded Joints	
Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Fittings	ASTM D2467, Cell Classification 12454-B, bearing NSF seal.
	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld.
	When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.
Material Classification	PVC-3
Schedule 80 PVC Pipe With Threaded Joints	
Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Fittings	ASTM D2464, Cell Classification 12454-B, bearing NSF seal.

Material Classification	PVC-4
PVC DWV Pipe (Single Wall) With Solvent Welded Joints	
Pipe	ASTM D1785, cell classification 12454-B, bearing NSF seal.
Fittings	ASTM D2665 and ASTM D3311, cell classification 12454-B, bearing NSF seal.
Material Classification	PVC-5
PVC DWV Pipe (Double Wall Containment) With Solvent Welded Joints	
Pipe	Sloan "GSR Contain-it"; with manufacturer's standard spacers, fittings, and suitable chemical service solvent or equal.
Fittings	ASTM D2665 and ASTM D3311, cell classification 12454-B, bearing NSF seal.
Material Classification	PVC-6
PVC Underdrain Pipe and Fittings	
Pipe	ASTM F758, solid or perforated wall, as specified herein, Cell Classification 12454-C or 12364-C, Type PS 46, with solvent welded or elastomeric gasket joints, as specified herein.
Fittings	ASTM D3034, Cell Classification 12454-B or 12454-C, wall thickness SDR 35, with solvent welded or elastomeric gasket joints, as specified herein.
Material Classification	PVC-7

Double-Contained Chemical Feed Pipe	
System	Prefabricated system consisting of primary pipe supported within a Schedule 80 PVC secondary containment housing. Primary pipe material and fittings shall be as specified for single-contained piping for the respective chemical.
Containment Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Interstitial Supporting Devices	Polypropylene spider clips or C-type, within the secondary containment pipe.
Material Classification	CPVC-1
Schedule 80 CPVC Pipe With Solvent Welded Joints	
Pipe	ASTM F441, Schedule 80, Cell Classification 23447-B, bearing NSF seal.
Fittings	ASTM F439, Cell Classification 23447-B, bearing NSF seal.
	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld.
	When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.
Material Classification	PE-1

PE Pipe (4 inch [100 mm] and smaller) With Socket Fusion Fittings	
Pipe	ASTM D3350, Cell Classification PE345434C.
	ASTM D2513, IPS, SDR11; Chevron Chemical Co. "Plexco Yellow-stripe PE3408 Gas Pipe".
Fittings	ASTM D1248, Type III, Class C, Grade P34.
	ASTM D2683, socket type, with wall thickness same as for pipe.
Material Classification	PE-2
PE Pipe (6 inch [150 mm] and larger) With Butt Fusion Fittings	
Pipe	ASTM D3350, Cell Classification PE345434C.
	ASTM D2513, IPS, SDR11; Chevron Chemical Co. "Plexco Yellow-stripe PE3408 Gas Pipe".
Fittings	ASTM D1248, Type III, Class C, Grade P34.
	ASTM D3261, butt heat fusion type, with wall thickness same as for pipe.
Material Classification	PE-3
PE Tubing With Compression Fittings	
Tubing	1/8 through 5/8 inch [3 through 16 mm] OD, 1/16 inch [1 mm] wall thickness, 130°F [54°C] max operating temperature.

Fittings	As recommended by the chlorine feed system manufacturer.
Material Classification	PE-4
PE Pipe	
Pipe	ASTM D3350, Cell Classification PE334434C.
	ASTM F714, DR as specified herein, Phillips "Driscopipe 1000", "Driscopipe 8600", or Plexco "PE 3408", as specified herein.
Fittings	Molded or manufactured from pipe; cell classification of material and pressure rating same as for pipe.
Material Classification	PE-5
Corrugated PE Drainage Tubing and Fittings	AASHTO M252 and ASTM F405, with solid or slotted wall, as specified herein.
Material Classification	PE-6
Polyethylene Tubing and Fittings	1/8 through 3/4 inch [3 through 19 mm] OD, 1/16-inch wall thickness, 130°F maximum operating temperature with compression fittings.
Material Classification	PP-1
Schedule 40 PP Pipe With Socket Fusion Fittings	
Pipe	ASTM D4101, Class 1, virgin, unpigmented homopolymer without additives or UV stabilizer; Enfield or Orion.
	Dimensions in accordance with ASTM D2447.

Fittings	Same material as pipe.
	Socket fusion type compatible with the pipe; Enfield or Orion.
Material Classification	PP-2
PP DWV Pipe With Heat Fused Joints	
Pipe	Schedule 40, ASTM D4101. Orion "Brownline" for standard type or "Blueline" for flame retardant type, Enfield, or R&G Sloan.
Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard heat fused socket joint. Solvent weld joints not permitted.
Material Classification	PP-3
PP DWV Pipe With Mechanical Joints	
Pipe	Schedule 40, ASTM D4101. Orion "Brownline" for standard type or "Blueline" for flame retardant type, Enfield, or R&G Sloan.
Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard.
Material Classification	PVDF-1
PVDF DWV Pipe With Heat Fused Joints	
Pipe	Schedule 40, UL 94-VO, non-combustible. Orion or equal.

Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard heat fused socket joint. Solvent weld joints not permitted.
Material Classification	PVDF-2
PVDF DWV Pipe With Mechanical Joints	
Pipe	Schedule 40, UL 94-VO, non-combustible. Orion or equal.
Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard.
Material Classification	PVDF-3
Schedule 80 PVDF With Socket Type Heat Fusion Welded Joints	
Pipe	ASTM D3222 for Type 1 homopolymers. Manufactured to wall thicknesses specified in ASTM D1785 for Schedule 80 Pipe.
Fittings	ASTM D2467.
	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a heat fusion weld.
	When acceptable to the Engineer, threaded joints may be used instead of solvent welded joints for the purpose of facilitating disassembly. The use of threaded joints in this system shall be held to a minimum.

Material Classification	PVDF-4
Schedule 80 PVDF With Threaded Joints	
Pipe	ASTM D3222 for Type 1 homopolymers manufactured to wall thicknesses specified in ASTM D1785 for Schedule 80 Pipe.
Fittings	ASTM D2464.
Material Classification	RPT-1
Reinforced Plastic Tubing	Wire reinforced PVC hose; Cobon Plastics Corp. "Cobovin Type S" or NewAge Industries Inc. "Vardex".

2.1.02 Accessory Materials. Accessory materials for the miscellaneous plastic pipe systems shall be as indicated.

Material Classification	FRP-1
Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ASTM A307, Grade B, galvanized, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
Flat Washers	ANSI B18.22.1, plain, galvanized.
Flange Gaskets	Full face, 1/8 inch (3 mm) thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.
Material Classification	PVC-1 through PVC-7, and PVDF-1 through PVDF-4
Flanges	Diameter and drilling shall conform to

	ANSI/ASME B16.5, Class 150.
	Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
	Stainless steel for DWV and sulfuric acid feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain.
	Stainless steel for DWV and sulfuric acid feed systems, galvanized steel for all other systems.
Flange Gaskets	Full face, 1/8 inch (3 mm) thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.
Material Classification	CPVC-1
Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
	Stainless steel for chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain.
	Stainless steel for chemical feed systems, galvanized steel for all other systems.

Flange Gaskets	Full face, 1/8 inch (3 mm) thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.
Material Classification	PE-1 through PE-6
Flanges	Schedule 80 PVC; diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ANSI B18.2.1, ASTM A193, AISI Type 304, heavy hex head, length such that after installation the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut. ASTM A194, AISI Type, ANSI/ASME B18.2.2, heavy hex pattern.
Fittings and Flange Adapters	Molded or manufactured from the pipe; cell classification of material and pressure rating same as for pipe.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation.

3.2 LEAKAGE AND PRESSURE TESTS. After installation, plastic piping shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All plastic piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.3 SCHEDULE. See Miscellaneous Plastic Pipe, Tubing and Accessories Schedule 15067-S01.

End of Section

SECTION 15069

CAST IRON SOIL PIPE AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of cast iron soil pipe and accessories for the services as indicated in the Contract Documents. Cast iron soil pipe shall be furnished complete with all fittings and other accessories specified herein.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but shall not be limited to, the following:

Gaskets.

Sleeves.

Name of Manufacturer.

Type and Model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.3 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Cast iron soil pipe materials shall be as indicated.

Material Classification	CI - 1
Bell and Spigot	
Pipe and Fittings	Bell and spigot type, ASTM A74.
Jointing Material	Rubber gaskets, ASTM C564.
Material Classification	CI - 2
Hubless	
Pipe and Fittings	Hubless type, CIPSI 301.
Jointing Material	Rubber sleeves, CIPSI 310.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation.
3.2 LEAKAGE AND PRESSURE TESTS. After installation, cast iron soil pipe shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All cast iron soil piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15070

COPPER TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of copper tubing and accessories for the services as indicated in the Contract Documents. Copper tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but shall not be limited to, the following:

Expansion joints.

Flange gaskets.

Insulating (dielectric) couplings, threaded and flanged.

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.3 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Copper tubing materials shall be as indicated.

Material Classification	CU-1
Water Tubing With Flared Fittings	
Tubing	Soft annealed copper tubing, ASTM B88, Type K.
Fittings	Flared, ANSI/ASME B16.26.
Material Classification	CU-2
Water Tubing With Flanged Fittings	
Tubing	Hard drawn copper tubing, ASTM B88, Type L.
Fittings	Flanges, ANSI B16.24, Class 150, cast bronze, brazed joint.
Material Classification	CU-3
Water Tubing With Solder Joints	
Tubing	Hard drawn copper tubing, ASTM B88, Type L.
Fittings	Solder joint, ANSI B16.18, or ANSI/ASME B16.22.
Material Classification	CU-4
Chemical Feed Tubing With Union Fittings	
Tubing	Soft annealed copper tubing, ASTM B88, Type K, cadmium plated for chlorine services.

Fittings	Union type with nonmetallic gasket or chemical lead alloy gasket containing 2-4 percent antimony. Fittings will be brazed to tubing.
Material Classification	CU-5
Instrument Tubing With Compression Fittings	
Tubing	Soft annealed copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280.
Fittings	Compression type, brass, Crawford "Swagelok" or Parker Hannifin "CPI".
Material Classification	CU-6
ACR Tubing With Brazed Fittings	
Tubing	Hard drawn ACR copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280.
Fittings	Brazed.
Material Classification	CU-7
Copper Hydraulic Tubing With Compression Fittings	
Tubing	ASTM B75, seamless, soft annealed, wall thickness as specified herein.
Fittings	Compression type, brass, Crawford "Swagelok" or Parker Hannifin "CPI".

2.1.02 Accessory Materials. Accessory materials for the copper tubing systems shall be as indicated.

Insulating Fittings

Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene-lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm beyond outer face of the nut.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch (3 mm) thick.
Expansion Joints	Tempflex "Model HB Expansion Compensators" with copper tube ends.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation.

3.2 LEAKAGE AND PRESSURE TESTS. After installation, copper tubing shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All copper tubing shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15080

ROLLER GATES

PART 1 – GENERAL

1.1 SCOPE**.** This section includes the furnishing, installation, and testing of rising or non-rising stem sluice gates with or without motor operated floor stands and wall thimbles.

The gates shall conform to the current edition of AWWA Standard C-501 except as otherwise specified in the Contract Documents.

The gates shall be designed for indoor or outdoor operation in hazardous or non-hazardous locations in sewage, as scheduled on the Drawings, and may or may not be designed for modulating service.

If the gates shall be equipped with control equipment suitable for remote operation from a remote control panel and/or a remote computer signal, refer to the Master Specifications in Divisions 16 and 17 for installation and connection of controls.

1.2 GENERAL.

1.2.01 Governing Standards.

ANSI A 21.6 (AWWA C106) – Specification for Cast Iron Pipe Centrifugally Cast in Metal Molds for Water and Other Liquids.

ANSI A 21.8 (AWWA C108) Specification for Cast Iron Pipe Centrifugally Cast in Sand Molds for Water and other Liquids.

ANSI A 21.51 (AWWA C151), Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds for Water or Other Liquids.

ANSI B 1.1- Specification for Unified Screw Threads," Course Thread Series, Class 2 Fit, for Tapped Holes.

ANSI B 1.1, "Screw Threads," Course Thread Series, Class 2.

ANSI B 16.1, "Cast Iron Pipe Flanges and Flanged Fittings,' Class 125.

ANSI B 16.2 – Specification for Cast Iron Pipe Flanges and Flanged Fittings," Class 250.

ASTM A126 (American Society for Testing and Materials) – Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, “Class B”.

ASTM A167 – Specification for Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet and Strips. Grade 3

ASTM A276 – Specification for Cold Finished, Stainless, and Heat Resisting Steel Bars. Type 316.

ASTM A536 – Specification for Ductile Iron Castings,” Grade 70-50-05.

ASTM A653 - Specification for Steel Sheet, Zinc – Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.”
DWSD Specification S-102-1, “Cast Iron Pipe,” revised October 1973.

ASTM B98 – Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

ASTM B584 – Specification for Copper Alloy Sand Castings for General Applications.

ASTM B21, “Naval Brass Rod, Bar, and Shapes.”

ASTM B144, “High Leaded Tin-Bronze Sand Castings,” Alloy 3A.

ASTM F104, (F112600M7) – Classification System for Nonmetallic Gasket Materials.

AWWA C501 – Cast Iron Sluice Gates.

DWSD Specification S-658-2, “Ductile Iron Pipe, January 1973.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit detailed Shop Drawings showing sluice gate installation dimensions and details and materials of construction of all sluice gate components as called for in Master Specification Section 1180, Submittals. Complete wiring and control diagrams shall be submitted per Master Specification Division 16000, Electrical and Division 12000, Instrumentation and Controls.

1.4 DELIVERY STORAGE AND HANDLING. Sluice gates are provided with locking plates to hold the disc firmly in place in the guides during shipping and installation. Gates can be lifted by a chain or sling through the stem hole in the disc only when locking plates are in place. When lifting gates, take special care to protect machined surfaces and wedges. Locking plates must be removed before opening gate.

Equipment should be stored in a clean, dry area on planks or timbers over an even surface to keep them off the ground and to prevent distortion. Equipment should also be covered to protect seat facings and other machined surfaces from foreign matter. Sluice gates should not be stacked more than three high, and then, only with heavy timber blocking placed between the gates to prevent damage to gates.

To prevent bending when lifting, handling and storing, stems should be supported over their full length. The threaded portion of the stem is protected by a heavy fiber cover, which should not be removed until the stem is ready for installation. Couplings and thrust nuts are shipped in place on the stems and should be removed prior to installation. Stop collars are normally shipped in a bag or box accompanying the floor stands. Operating mechanisms should be handled and treated as precision machinery and protected accordingly.

1.5 WARRANTY. The manufacturer shall furnish to the Owner the warranty as specified in the Master Specification Section 01170, Warranties and Bonds, for the equipment and materials installed under this section of the specifications. Upon receipt of notice from the Owner of failure of any part of the guaranteed materials or equipment during the warranty period, new replacement part or parts shall be furnished and installed promptly by the Contractor at no additional cost to the Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Sluice gates shall be as manufactured by Rodney Hunt Company, Hydro Gate Corporation, Watermain Industries or equal.

2.2 MATERIALS.

2.2.01 Sluice Gate. Sluice gates shall be ductile iron, bronze mounted heavy duty, flanged frame, with or without flush bottom closure as scheduled on the Drawings. Each gate shall be equipped with an adjustable side and top wedge system and designed for a maximum seating or unseating head of 40 (12.2 m) feet of water unless otherwise scheduled on the Drawings.

2.2.02 Wall Thimble. A separate ductile iron wall thimble, Type F, 18 inches (45.7 cm) in depth shall be furnished by the manufacturer for each sluice gate. Thimbles shall be cast in one piece with integral flanged wall ribs and grout holes and shall be of such dimensions and design as approved by the Engineer.

Wall thickness shall not be less than AWWA, Class D; and the flange thickness shall be not less than ANSI, Class 125. The thimble flange faces shall be faced, drilled, and tapped for flange studs as required.

2.2.03 Stem. The top of the stem shall project at least 1 inch (2.54cm) above the operating lift nut when gate is in closed position. The stem diameter shall be selected to limit the l/r ratio between supports to no more than 120, And the Stem couplings, if required, shall be made of bronze and shall be internally threaded and provided with pins of the required size. Note that, the stem shall be made of Type 316 stainless steel and the operating threads shall be Acme Standard or equal accurately rolled or cut in a lathe.

2.2.04 Guides. The sluice gate guides shall be made of ductile iron and shall be of such length that at least one-half the height of the leaf shall be supported by the guides when the gate is in the fully open position. The extension of the gate guides shall be securely anchored to the concrete by means of Type 316 stainless steel anchor bolts, nuts, and pipe spacers. The anchor bolts shall be embedded in the concrete not less than 8 inches (20.3 cm), and the guide slots shall be machined and lined for the full length of the guides with bronze linings. The guide linings shall provide not more than 1/6 inch (1.6 mm) clearance with the tongues on the sides of the leaf. In the case, where the guides are not integrally cast, they shall be doweled and bolted to the gate frame, and the brackets in contact with the wedges on the leaf shall be heavily ribbed to withstand the thrust due to water pressure and wedging action of the leaf wedges, and shall be machined and fitted with bronze wedge facings, which shall be machined on all bearing surfaces to make accurate contact with the wedges.

2.2.05 Stem Guides. Stem guides if required shall be split bronze bushings.
Their brackets shall be made of cast iron with heavily ribbed sections and shall be mounted to the wall with stainless steel anchor bolts and nuts. The distance from the wall to the centerline of the stem shall be readily adjustable. The bushings shall be mounted to the bracket and doweled in such a manner that the stem may be removed without disturbing the alignment of the guide bracket and bushings, where all bolts and nuts shall be made of stainless steel 316, and the bracket and anchor bolts shall be of sufficient strength to withstand all possible stress from operation of the gate.

2.2.06 Wedges. The gate leaves shall be equipped with adjustable bronze wedges of approved design to provide uniform distribution of the seating and unseating pressure. Each leaf shall have machined pads for the wedges. The number, arrangement, location, and method of adjustment of the wedges shall ensure that any leakage occurring shall be 0.1 gallon per minute per linear foot of the surface perimeter. The wedges shall be held in place and adjusted by means of bronze studs, nuts, and washers and shall be machined on all bearing surfaces and shall make accurate contact with the wedge seats attached to the frame.

2.2.07 Gaskets. All gaskets necessary for a complete installation shall be furnished and shall be one piece, where applicable, and shall be 1/16 of an inch (1.6 mm) full face, 3000, manufactured by Garlock or Anchor Packing Superheat 490C, or equal.

2.2.08 Painting. All iron and steel surfaces except machined surfaces, submerged or non-submerged, shall be surface prepared and shop painted as defined in Master Specification Section 09900, Painting, Paragraph 2.2 Materials using National Sanitation Foundation Standard 61 certified products.

2.2.09 Gray and Ductile Gray Cast Iron. All cast iron castings shall be made from cast iron which shall be in conformity with the current ASTM A126, Class B (31,000 psi (213,714 kPa) minimum tensile strength) or equal, and shall be clean, smooth, free from blow or sand holes, porosity, cold shuts, cracks, or other physical defects and shall be tough and close grained. All ductile iron casting shall comply in similar fashion with ASTM A536. Note that, plugging, patching, or welding of defective castings will not be permitted except that minor repairs may be made with prior approval of the Engineer.

2.2.10 Steel. Steel used in the manufacture of the sluice gate and its appurtenances shall be of the best quality open hearth or electric furnace steel having an ultimate tensile strength of not less than 36,000 psi (248,184 kPa), and shall be hot-dipped galvanized after fabrication.

2.2.11 Stainless Steel. The stainless steel for operating stem, bolts, nuts and studs shall be in conformity with the current ASTM A276, Type 316, or approved equal.

2.2.12 Bronze. All bronze parts shall be of uniform composition and quality, shall be free from surface cracks or other defects, and shall conform accurately to the required dimensions, where all defective parts and parts not in conformity with these specifications shall be rejected. The bronze for the stem nut, couplings, thrust nuts, wedges, wedge seats, and gate seats shall be in conformity with the current ASTM B147, Alloy 8B, or approved equal. Seat facing applied by forging shall be in conformity with the current ASTM B21.The bronze for stem guide bushings shall be in conformity with the current ASTM B144, Alloy 3A, or approved equal. Bronze bolts, studs, nuts, anchor bolts, and coupling pins shall be in conformity with the current ASTM B98.

2.2.13 Crank and Hand Wheel – Operated Floor Stands. The geared floor stand shall have a weatherproof, housing, with a bronze operating nut, mounted on a high strength pedestal. Tapered roller bearings shall be located above and below bronze operating nut to support the output thrust of the floor stand. The gearing shall be accurately cut and of proper design to support the load conditions without undue stress. The shaft shall be mounted to provide low friction operation and to resist axial and radial thrusts. Mechanical seals shall be provided around the operating nut and the pinion shaft to prevent lubrication from leaving the unit and moisture from entering the sealed housing. The reduction gear case shall be precision machined and equipped with roller or needle bearings sealed about the reduction shafts. Lubrication fittings shall be provided for all bearings. Crank operated floor stands will be selected so that no more than 40 lb (18.12 Kg) effort shall be needed on the crank to open or close the sluice gate or slide gate. And gear ratio shall be identified by drawings or Engineer. Crank handles and handwheels shall be worked with the direction of rotation to open the valve (usually counterclockwise). Each crank handle or handwheel shall have cast thereon the word "Open" and an arrow indicating the direction to open. The number of turns required to close the gate shall be worked in an appropriate and visible location.

2.2.14 Electric Operators. Electric operators shall be per Master Specification Section 15180, Valve and Gate Actuators.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Installation of the sluice gates, guides, stem supports, and operators shall be in accordance with the manufacturer's detailed instructions.
Prior to the pouring of concrete for the wall containing the sluice gate, the wall thimble shall be accurately placed in the wall forms in accordance with the manufacturer's instruction. Each wall thimble shall be internally braced and bolted to the forms to prevent any distortion during installation operations. Each operator shall be accurately set and plumbed and shall be in proper alignment with the gate and stem before it is installed in place. Operating stems shall be installed in proper alignment and shall not bind in the lift nut or stem guides.

3.2 FIELD QUALITY CONTROL. If inspection or tests disclose defects or non-compliance with the provisions of these specifications, such defects or improperly installed work shall be replaced or adjusted and the tests repeated until compliance with these specifications is obtained.

3.2.01 Field Testing. Following the completion of each roller gate installation, the gate shall be operated through at least two complete open-close cycles, the gate shall be readjusted and re-operated as necessary, and left in a condition acceptable to the Engineer. A field leakage test shall be performed by the Contractor after installation of the gates. Maximum permissible leakage shall be in accordance with AWWA C560. The manufacturer shall be notified of the test in sufficient time to enable him to have a representative present at the test site. After all adjustments have been made and the mechanisms properly lubricated, each gate slide shall be operated through one complete cycle as a final check on proper operation before starting the leakage test.

Complete operation and maintenance requirements shall be including complete manufacturers product data in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals.

3.2.02 Inspection. A representative of the manufacturer shall be present during installation and shall instruct the Contractor's personnel in proper installation procedures and supervise the installation. He shall approve the installation and witness the test.

3.3 MAINTENANCE. Complete training, operation and maintenance requirements shall be provided including complete manufacturers product data in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals. The manufacturer's representative shall instruct the Owner's personnel in the proper operation and maintenance of the Sluice Gates.

End of Section

SECTION 15082

CAST-IRON SLIDE GATES

PART 1 – GENERAL

1.1 SCOPE**.** This section includes the furnishing, installation, and testing of rising stem slide gates with or without motor operated floor stands and wall thimbles.

The gates shall conform to the current edition of AWWA Standard C-560 except as otherwise specified in the Contract Documents.

The gates shall be designed for indoor or outdoor operation in hazardous or non-hazardous locations in sewage, as scheduled on the Drawings, and may or may not be designed for modulating service.

If the gates shall be equipped with control equipment suitable for remote operation, Contractor shall conform to the Master Specifications, Divisions 16, Electrical and Division 17, Instrumentation and Controls for installation and connection of the control systems.

1.2 GENERAL.

1.2.01 Governing Standards.

AWWA – American Water Works Associtaion: C560 - Cast-Iron Slide Gates

AWWA/ANSI – American National Standard Institute: C540 - Power Actuating Devices for Valves and Slide Gates

AISI – American Iron and Steel Institute: 1117 - Standard for Resulfured Carbon Steel

AISI – 4140 - Standard for Alloy Steel

AISI – 8620 - Standard for Alloy Steel

ANSI/ASME – American Society of Mechanical Engineers: B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

ANSI/ASME: B46.1 - Standard for Surface Textures (Surface Roughness, Waviness, and Lay)

ANSI/ASTM – American Society for Testing and Materials: D471 - Standard Test Method for Rubber Property - Effect of Liquids

ASTM – A36/A36M - Standard Specification for Carbon Structural Steel

ASTM – A48 - Standard Specifications for Gray Iron Castings

ASTM – A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM – A276 - Standard Specification for Stainless Steel Bars and Shapes

ASTM – A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars, Hot-Rolled or Cold-Finished

ASTM – B21 - Standard Specification for Naval Brass Rod, Bar, and Shapes

ASTM – B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes

ASTM – B138 - Standard Specification for Manganese Bronze Rod, Bar, and Shapes

ASTM – B139/B139M - Standard Specification for Phosphor Bronze Rod, Bar, and Shapes

ASTM – B148 - Standard Specification for Aluminum-Bronze Sand Castings

ASTM – B505 - Standard Specification for Copper-Base Alloy Continuous Castings

ASTM – B584 - Standard Specification for Copper Alloy Sand Castings for General Applications

ASTM – D1149 - Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber

ASTM – D2000 - Standard Classification System for Rubber Products in Automotive Applications

ASTM – F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

ASTM – F594 - Standard Specification for Stainless Steel Nuts

CDA Copper Alloy Numbers (Note: CA precedes alloy numbers defined by CDA)

SSPC – SP6 - Commercial Blast Cleaning

SSPC – SP10 - Near-White Blast Cleaning

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit detailed Shop Drawings showing slide gate installation dimensions and details and materials of construction of all slide gate components as called for in Master Specification, Section 1180, Submittals. Complete wiring and control diagrams shall be submitted in accordance with Master Specification, Division 16000, Electrical and Division 17000, Instrumentation and Controls.

1.4 DELIVERY STORAGE AND HANDLING. Slide gates are provided with locking plates to hold the disc firmly in place in the guides during shipping and installation. Gates can be lifted by a chain or sling through the stem hole in the disc only when locking plates are in place. When lifting gates, take special care to protect machined surfaces and wedges. Locking plates must be removed before opening gate.

Equipment should be stored in a clean, dry area on planks or timbers over an even surface to keep them off the ground and to prevent distortion. Equipment should also be covered to protect seat facings and other machined surfaces from foreign matter. Slide gates should not be stacked more than three high, and then, only with heavy timber blocking placed between the gates to prevent damage to gates.

To prevent bending when lifting, handling and storing, stems should be supported over their full length. The threaded portion of the stem is protected by a heavy fiber cover, which should not be removed until the stem is ready for installation. Couplings and thrust nuts are shipped in place on the stems and should be removed prior to installation. Stop collars are normally shipped in a bag or box accompanying the floor stands. Operating mechanisms should be handled and treated as precision machinery and protected accordingly.

1.5 WARRANTY. The manufacturer shall furnish to the Owner the warranty as specified in the Master Specification Section 01170, Warranties and Bonds, for the equipment and materials installed under this section of the specifications. Upon receipt of notice from the Owner of failure of any part of the guaranteed materials or equipment during the warranty period, new replacement part or parts shall be furnished and installed promptly by the Contractor at no additional cost to the Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Slide gates shall be as manufactured by Rodney Hunt Company, Hydro Gate Corporation, Watermain Industries or equal.

2.2 MATERIALS. Materials shall conform to the following specifications, however, the materials subject to dezincification or dealuminization shall not be used. The manufacturer/supplier shall make a declaration to this effect.

Thimble, frame, guides, slide, stem guides, and gear housing	Cast-iron – ASTM A126, class B; or ASTM A48, class 30.
Yoke and pedestal	Cast-iron – ASTM A126, Class B; or ASTM A48, class 30; or steel - ASTM A36.
Gears	Steel – AISI 8620, AISI 4140, or AISI 1117; bronze – ASTM B148 (CA 952, CA 954, or CA 958), ASTM B584 (CA 865 or CA 867).
Bearings	Bronze – ASTM B148 (CA 954).
Wedges	Bronze – ASTM B584 (CA 836, CA 865, CA 863, or CA 873).
Stem couplings	Bronze – ASTM B584 (CA 865, CA 863, or CA 873 stainless steel - ASTM A582, type 303; or ASTM A276, type 302 or 304.
Thrust nut and gate actuator lift nut	Bronze – ASTM B584 (AC 865, CA 863, or CA 873), ASTM B505 (C95800).
Seating faces and stem guide	Bronze – ASTM B21 (CA 464 or CA 482), ASTM B138 (CA 675), ASTM B98 (CA 651 or CA 655), ASTM B139 (CA 510); or ASTM B584 (CA 836, CA 865, CA 863 or CA 873); stainless steel - ASTM A276, type 302 or 304.
Stem guide bushings	Bronze – ASTM B584 (CA 932 or CA 873), ASTM B98 (CA 651 or CA 655), or ASTM B139 (CA 510).
Stems	Stainless steel ASTM A582, type 303; or ASTM A276, types 302 or 304.
Anchor bolts and fasteners	Stainless steel ASTM F593 or ASTM F594, alloy group 1 or group 2; or bronze - ASTM B98 (CA 651 or CA 655).
Flush-bottom seal	Elastomeric materials - ASTM D2000.
Flush-bottom retainer bar	Cast-iron – ASTM A126, class B; stainless steel - ASTM A276, type 302 or 304; ASTM A582, type 303; bronze - ASTM B98 (CA 651 or CA 655); or ASTM B138 (CA 675).

2.2.01 Slide Gate. Cast iron slide gate shall have frame and slide. The frame and slide shall have embedded bronze seating strips, which shall be pressed together by the attached wedging devices when the gate is closed.

Slide gates shall be cast-iron, bronze mounted heavy duty, flanged frame, with or without flush bottom closure as scheduled on the Drawings. Each gate shall be equipped with an adjustable side and top wedge system and designed for a maximum seating or unseating head of water as scheduled on the Drawings.

The gate slide shall be made of cast iron faces and be of one-piece construction, with strengthening ribs where required; and a reinforced section to receive the seating faces. The slide shall be square or rectangular in shape with integrally cast vertical and horizontal reinforcing ribs. A heavy reinforcing rib along each side shall be provided to ensure rigidity between side wedges. The slide shall be designed to operate under maximum specified differential head with the minimum safety factory of five (5). Guide tongues along each side of the slide shall be machined accurately on contact surfaces. A nut pocket shall be cast on the vertical centerline of the gate and shall be provided with a threaded block for attaching the stem to the slide. Pads for side wedges and top and bottom wedges, when required shall be integrally cast on the slide and machined to receive the adjustable wedges. The maximum allowable clearance between the slide and the slide guide shall be 1/16 in (1.6 mm).

2.2.02 Frame. The gate frame shall be cast iron and be of ample section and cast in one-piece. The frame shall be designed for the seating and unseating head indicated on the drawings with a minimum safety factor of five (5). All surfaces forming joints or bearings shall be machined. The frame shall be machined on the rear face to bolt directly to the machined face of the wall.

2.2.03 Frame Guides. The slide gate guides shall be made of cast iron and bolted to the frame or cast integrally with it. Guides shall be machined on all bearing and contact faces. Guides shall be designed for the design head indicated with a minimum safety factor of five (5). The guides shall be of such length so as to support at least one-half the vertical height of the slide when the slide is in the open position.

The extension of the gate guides shall be securely anchored to the concrete by means of Type 316 stainless steel anchor bolts, nuts, and pipe spacers. The anchor bolts shall be embedded in the concrete not less than 8 inches (20.3 cm), and the guide slots shall be machined and lined for the full length of the guides with bronze linings. In the case, where the guides are not integrally cast, they shall be doweled and bolted to the gate frame, and the brackets in contact with the wedges on the slide shall be heavily ribbed to withstand the thrust due to water pressure and wedging action of the slide wedges, and shall be machined and fitted with bronze wedge facings, which shall be machined on all bearing surfaces to make accurate contact with the wedges. Guide grooves shall be machined on all contact faces.

Overall clearances with slide tongue shall be not more than 1/8 in (3.2 mm). Faces for mounting of wedging devices shall be fully machined. Frames shall be self-contained (S/C) as listed in the “Gate Schedule.”

Round opening gates shall have a circular flange cast as part of the frame for mounting to a wall or pipe flange. All wall thimble-mounted gates shall have a square or rectangular flanged-back frame. The frame shall be fully machined and drilled to match the wall thimble. Gates mounted on pipe flanges shall be furnished with partial drilling per manufacturer’s recommendations.

2.2.04 Yoke. Self-contained gates shall be provided with a cast-iron or structural-steel yoke designed to withstand the thrust of the floorstand or hoist when a 40 lbf (178 N) effort is placed on the handwheel or crank with a safety factor of five (5). The top of the yoke shall be machined to receive the operating mechanism. The pads on the yoke that contact those on the top of the guides shall be machined on contact faces and bolted to the guides.

2.2.05 Wall Thimble. The wall thimble shall be made of cast iron and shall be provided by gate manufacturer. A pipe flange or F-shaped or E-shaped, shall be provided with a suitable end for attaching to the connecting opening as specified on the Gate Schedule. The front or mounting flange, shall be machined and shall be drilled and tapped to the same template used for its particular gate frame. A ring shall be cast on the periphery of the wall thimble to form a water stop and anchor ring in the concrete. Thimbles shall be of such dimensions and design as approved by the Engineer. The gate shall be attached to the wall thimble with bolts or studs to withstand the design forces with a safety factor of five (5). For gate mounting to thimbles, an adequate number of holes shall be provided in the flange on the back of the gate to prevent leakage under the design heads and to resist the shearing action caused by closing and opening forces.

2.2.06 Stem. The top of the stem shall project at least 1 inch (2.54cm) above the operating lift nut when gate is in closed position. Stems shall be manufactured from stainless steel sized to withstand the axial compressive and tensile forces created during gate operation under the specified differential heads and to transmit in compression at least two (2) times the rated output of the lift with a 40 lbf (178 N) effort on the crank or handwheel, or (1.25) times the stall thrust of the electric actuator. Threading on stems shall be rolled with double-lead threads of the Acme type. Cut threads will not be allowed. The contact surfaces of the threads shall have a maximum 16 micro-inch (406 micro-mm) finish. Stem couplings shall have internal threads for transmitting the full thrust of the stem and shall be held in place on the stem with a key, simultaneously engaging the coupling and both stems. The Stem couplings, if required, shall be made of bronze.

2.2.07 Stem Guides. Stem guides shall be fully adjustable, heavy duty castings, with 2 piece cast bronze removable collars. The stem guides shall be properly spaced to support the stem as a long column, with maximum spacing not to exceed a l/r (length/radius of gyration) of 200.

2.2.08 Wedges. The gate slides shall be equipped with adjustable bronze wedges of approved design to provide uniform distribution of the seating and unseating pressure. Each slide shall have machined pads for the wedges. The number, arrangement, location, and method of adjustment of the wedges shall ensure that any leakage occurring shall be 0.1 gallon per minute per linear foot (0.378 L/min per 30.5 cm) of the surface perimeter. The wedges shall be held in place and adjusted by means of bronze studs, nuts, and washers and shall be machined on all bearing surfaces and shall make accurate contact with the wedge seats attached to the frame.

2.2.09 Seals. Resilient seals for flush-bottom gates shall be extruded or molded natural or synthetic rubber. Reclaimed rubber shall not be used. Flush-bottom gates shall be provided with a frame-mounted flush-bottom seal. The solid bulb resilient rubber seal shall be firmly held in place using stainless steel retainers and corrosion-resistant fasteners. The full length of the bottom edge of the slide shall be machined for making uniform contact with the seal when it is mounted on the frame. The differential pressure on the rubber seal shall be variable by adjustment of wedges on the gate. The seal shall be designed to provide for the minimum leakage as specified.

2.2.10 Painting. All iron and steel surfaces except machined surfaces, submerged or non-submerged, shall be surface prepared and shop painted as defined in Master Specification Section 09900, Painting, Paragraph 2.2 Materials using National Sanitation Foundation Standard 61 certified products.

2.2.11 Manual Lifting Devices. The manual lift mechanism shall have either a direct drive handwheel without reduction gearing, or shall be crank-actuated with either single or double-reduction gearing, as necessary to meet lifting capacity required. The lift mechanism shall be sized to permit slide operation with an effort of not more than 40 lbf (178 N) pull on the handwheel/handcrank or 50 lbf-ft (68 N-m) torque on the lift nut or input shaft, depending on the lift type. Maximum pull or torque to start the slide in motion must not exceed one and one-half times this amount. All components of the lift mechanism shall be designed to withstand these input efforts or torque's with a minimum safety factor of five (5). The floor stand shall have a weatherproof, housing, with a bronze-operating nut, mounted on a high strength pedestal. Tapered roller bearings shall be located above and below the flange on the lift bronze operating nut to support the output thrust of the floor stand.
The gearing shall be accurately cut and be of proper design to support the load conditions without undue stress. The shaft shall be mounted to provide low friction operation and to resist axial and radial thrusts.

Mechanical seals shall be provided around the operating nut and the pinion shaft to prevent lubrication from leaving the unit and moisture from entering the sealed housing. The reduction gear case shall be precision machined and equipped with roller or needle bearings sealed about the reduction shafts. Lubrication fittings shall be provided for all bearings. Crank operated floor stands will be selected so that no more than 40 lbf (178 N) effort shall be needed on the crank to open or close the slide gate. Crank handles and handwheels shall be worked with the direction of rotation to open the valve (usually counterclockwise). Each crank handle or handwheel shall have cast there on the word “Open” and an arrow indicating the direction to open. The number of turns required to close the gate shall be worked in an appropriate and visible location.

2.2.12 Electric Operators. Electric operators shall be as per AWWA standard C-540 and Master Specification, Section 15180, Valve and Gate Actuators.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Installation of the slide gates, guides, stem supports, and operators shall be in accordance with the manufacturer’s detailed instructions.
Prior to the pouring of concrete for the wall containing the slide gate, the wall thimble shall be accurately placed in the wall forms in accordance with the manufacturer’s instruction. Each wall thimble shall be internally braced and bolted to the forms to prevent any distortion during installation operations. Each operator shall be accurately set and plumbed and shall be in proper alignment with the gate and stem before it is installed in place. Operating stems shall be installed in proper alignment and shall not bind in the lift nut or stem guides.

3.2 FIELD QUALITY CONTROL. If inspection or tests disclose defects or non-compliance with the provisions of these specifications, such defects or improperly installed work shall be replaced or adjusted and the tests repeated until compliance with these specifications is obtained.

3.2.01 Field Testing. The slide gate shall be tested by being completely operated from open to closed positions in the presence of the Engineer with the head on the gate at maximum elevation as directed by the Engineer. Under these conditions, the gates shall move freely in their guides without binding, and the stems shall be truly vertical with no perceptible side play, and stand shall be tested for mechanical operation. All slide gates shall be tested for leakage. The wedges shall be adjusted to ensure that any leakage, which occurs, does not exceed the amount permitted by AWWA C-501. The Contractor shall make all arrangements; provide all necessary labor, materials, or equipment; and make all adjustments necessary for the performance of operating test which must be conducted in the presence of the Engineer.

3.2.02 Inspection. A representative of the manufacturer shall be present during installation and shall instruct the Contractor's personnel in proper installation procedures and supervise the installation. He shall approve the installation and witness the test.

3.3 MAINTENANCE. Complete training, operation and maintenance requirements shall be provided including complete manufacturers product data in accordance with Master Specification, Section 01160, Training and Operations & Maintenance Manuals. The manufacturer's representative shall instruct the Owner's personnel in the proper operation and maintenance of the Slide Gates.

End of Section

SECTION 15084

STOP LOGS

PART 1 – GENERAL

1.1 SCOPE. This section covers stop logs which shall be furnished complete with guides, seals, relevant hardware and appurtenances.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Contractor and subsequently approved by the Engineer. Stop logs shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest products of a manufacturer regularly engaged in the production of stop logs. Each stop log shall be provided with a number plate. Numerals shall be at least 1 inch high and shall be black backed enamel on anodized aluminum plate. The location of number plates and the method of attachment shall be acceptable to the Contractor. The number assigned to each stop log shall be as determined by the Contractor. Log shall be such that the flexural stresses do not exceed 1/5 of ultimate strength or 1/3 of yield strength. Design flexural stress of aluminum shall not exceed 7,000 psi (335 kPa). Log and lifting beam design shall be such that the flexural stresses do not exceed 1/5 of ultimate strength or 1/3 of yield strength. Design flexural stress of aluminum shall not exceed 7,000 psi (335 kPa).

1.3 SUBMITTALS. Complete drawings, construction details, and specifications covering the stop logs and appurtenances shall be submitted in accordance with the submittal section. Each drawing shall be identified with the stop log designation as relevant to the Work.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide stop logs and related furnishings as manufactured by Rodney Hunt Company, Fontaine, Waterman, Hydrogate, or approved equal.

2.2 MATERIALS.

Stop Logs	Aluminum B308 6061-T6 or Stainless Steel Type 316L

Lifting Lugs	Aluminum B308 6061-T6 or Stainless Steel Type 316L
Guides	Aluminum B308 6061-T6 or Stainless Steel Type 316L
Seals	
1. Sides	Lip Seal–ASTM D2000, Grade 2BC 615, Extruded Neoprene, Durometer 50
2. Bottom	Flush Lip Seal-ASTM D2000, Grade 2BC 515, Extruded Neoprene, Durometer 50

2.3 FABRICATION. Stop logs shall be of one piece extruded aluminum, or fabricated stainless steel. Stop log panels shall be of height indicated and in height increments set by the manufacturer. Panels made of two or more extrusions shall be securely welded together to form a unit and joints shall be made watertight with neoprene seals or seal welding. All welding shall be in accordance with latest applicable codes of the American Welding Society (D1.2 for aluminum and D1.3 for stainless steel). The stop logs shall be fabricated in separate panels such that the largest panel is no greater than 8 feet (2.4 m) in height. Each panel shall have two stainless steel hooks to engage the lifting device. Adequate drainage and rapid release of air shall be provided for each log. The bottom of the log shall be extruded in a way to accept a specially extruded resilient seal to provide a flush bottom closure. The shape of the lip seal shall provide a seating surface having a minimum width of 1 inch (2.4 cm). The vertical face of the seal shall be in contact with the seating surface of the guide or seal located on the frame to provide a proper seal at the corners. Stop logs shall be of sufficient weight to be submerged under their own weight.

2.4 GUIDES. The guides shall be of extruded aluminum or stainless steel, whichever material is the same as chosen for the logs, and shall be structural shapes or formed plates. The guides shall be designed for maximum rigidity and will be provided with a strap on the back of the guides for the embedded type to lock it into the concrete, or with a side angle for surfacing mounting using anchor bolts. The invert of the frame shall be an angle or channel welded to the lower ends of the guides to form a seating surface for the resilient seal mounted on the stop log.

2.5 SEALS. The seals shall be located along the bottom of the log section, between each stop log panel and along both sides of the log. Seals shall be mechanically attached to the log. Adhesives alone are not an acceptable mounting method. Seals shall be mounted in a manner that allows for easy replacement in the event of damage. Lip type seals shall be attached to the frame to restrict leakage. Under the condition which the log will be subjected to flow in both directions, the log and guide shall be provided with seals in both directions.

2.6 HARDWARE. All necessary attaching bolts and anchor bolts shall be stainless steel and furnished by the stop log manufacturer.

2.7 LIFTING DEVICE. Lifting device shall be suitable for inserting, retrieving and handling stop log panels. One (1) lifting device shall be provided for each stop log width. The lifting device shall be equipped with a suitable eyebolt for crane operation. The device shall be guided by the slot of the guide extrusion, and shall be capable of securing and releasing the stop logs panels with the use of a lanyard from the operating floor. The device shall be furnished with non-metallic wheels to guide the device in the slot. The lifting device may, at the manufacturer's option, be adjustable in widths to accommodate several widths of stop log openings.

2.8 PAINTING. All aluminum in contact with concrete shall have a heavy shop coat of bitumastic paint.

PART 3 – EXECUTION

3.1 INSTALLATION. The installation of all parts shall be done in a workmanlike manner and in accordance with detailed technical installation procedures supplied by the manufacturer.

3.2 TESTING. Upon completion of the installation, the contractor shall be required to make performance tests of the stop logs in the field, under the direction of the Engineer. Tests shall be performed in accordance with the requirements of Master Specification Section 01180, Equipment, Material, Parts and Tools.

3.3 FIELD QUALITY CONTROL. It shall be the Contractor's responsibility to handle, store, and install the stop logs in. strict accordance with manufacturer's drawings and recommendations. All stop logs of the same dimension shall be interchangeable from one slot to another and shall be tested for such interchangeability by actually installing each stop log in each slot in the field. Any maladjustment shall be corrected to the satisfaction of the Engineer.

End of Section

SECTION 15090

ANGLE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated angle valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Nameplates shall have black baked enamel letters at least 3/4 inch (19 mm) high on anodized aluminum plate.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Angle valves shall be suitable for use as throttling valves.

2.1.01 Valves VA-1.

Rating	Class 125
Code	MSS SP-80, Type 1
Body/Bonnet	ASTM B62, bronze, threaded bonnet, threaded packing nut, rising stem
Trim	
Seat	Integral to body
Disc	ASTM B62, bronze
Stem	ASTM B62, bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	-20 to 150°F (-29 to 66°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "504", or approved equal

2.1.02 Valves VA-2.

Rating	Class 150
Code	MSS SP-80, Type 2
Body/Bonnet	ASTM B62, bronze, union bonnet, threaded packing nut, rising stem
Trim	
Seat	Integral to body

Disc	PTFE
Stem	ASTM B62, bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	-20 to 150°F (-29 to 66°C)
Valve Operator	Handwheel
Manufacturers	Stockham "B-222T", Walworth "Fig 3096", or approved equal

2.1.03 Valves VA-3.

Rating	Class 125
Code	MSS SP-85, Type II
Body/Bonnet	ASTM A126, Class B, cast iron, bolted bonnet, OS&Y, rising stem
Trim	
Seat	ASTM B62, bronze, renewable
Disc	ASTM B62, bronze, renewable
Stem	ASTM B16, brass
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Flanged, flat faced
Temperature Limitations	-20 to 150°F (-29 to 66°C)
Valve Operator	Handwheel
Manufacturers	Powell "Fig 1254", or approved equal

2.1.04 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.05 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.06 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.
All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer’s standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1. INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15091

MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of 4 inch and smaller, manually operated or remote activated, two position (open-close) ball valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

Ball valves larger than 4 inch are covered in Master Specification Section 15103, AWWA Ball Valves.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VB-1.

Rating	500 psi (3.4 MPa]) nonshock cold WOG
Code	MSS SP-110
Type	In-line, two piece, end entry, regular port
Body/Bonnet	ASTM B584–C84400 bronze or ASTM B194, Grade 377, brass
Trim	
Seat	Reinforced Teflon
Ball	Brass, or chrome plated brass
Stem	Brass
Thrust Washer	Reinforced Teflon
Stem Seal	Teflon or Viton
End Connection	Threaded
Temp. Limitations	-20 to 400°F (-29 to 204°C])
Manufacturers	Conbraco Industries "Apollo 70-100 Series"; Powell "Fig 4210T", or approved equal

2.1.02 Valves VB-2.

Rating	800 psi (5.5 MPa) nonshock cold WOG

Code	MSS SP-110
Type	In-line, two piece, end entry, regular port
Body/Bonnet	ASTM A3512-CF8M stainless steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A276-316, stainless steel
Stem	ASTM A276-316, stainless steel
Thrust Washer	Reinforced Teflon
Stem Seal	Teflon or Viton
End Connection	Threaded
Temp. Limitations	-20 to 400°F (-29 to 204°C])
Manufacturers	Conbraco Industries "Apollo 76-100 Series"; Neles-Jamesbury "Series 300", or approved equal

2.1.03 Valves VB-3.

Rating	1000 psi (6.5 MPa) nonshock cold WOG
Code	MSS SP-110, NACE MR-01-75
Type	In-line, three piece, bolted body, regular port
Body/Bonnet	ASTM A351-CF8M, stainless steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A276-316, stainless steel
Stem	ASTM A276-316, stainless steel

Thrust Washer	Reinforced Teflon
Stem Seal	Reinforced Teflon
End Connection	Socketwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Conbraco Industries "Apollo 85-200 Series"; Neles-Jamesbury "Series 4000", or approved equal

2.1.04 Valves VB-4.

Rating	Class 150
Code	MSS SP-72
Type	In-line, split body, full port
Body/Bonnet	ASTM A216-WCB, cast steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A216-WCB, steel, chrome plated
Stem	ASTM A108-CS
Thrust Washer	Reinforced Teflon
Stem Packing	Manufacturer’s standard
End Connection	Flanged, ASME B16.5, Class 150, raised face
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Conbraco Industries "Apollo 88-200 Series", or approved equal

2.1.05 Valves VB-5.

Rating	Class 150
Code	MSS SP-72
Type	In-line, end entry, regular port
Body/Bonnet	ASTM A216-WCB, cast steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A216-WCB, steel, chrome plated
Stem	ASTM A108-CS
Thrust Washer	Reinforced Teflon
Stem Seal	Manufacturer’s standard
Body Seal	Reinforced Teflon
End Connection	Flanged, ASME B16.5, Class 150, raised face
Temp. Limitations	-20 to 400°F [-29 to 204°C]
Manufacturers	Conbraco Industries "Apollo 88-100 Series"; Neles-Jamesbury "Series 5000"; Powell "Fig 4224T", or approved equal

2.1.06 Valves VB-6.

Rating	800 psi [5.5 MPa] nonshock cold WOG
Code	ASME B16.34
Type	In-line, three piece, bolted body, full port
Body/Bonnet	ASTM A216-WCB, cast steel or ASTM A105, forged steel

Trim	
Seat	Reinforced Teflon
Ball	ASTM A108-CS, chrome plated
Stem	ASTM A108-CS
Thrust Washer	Reinforced Teflon
Stem Seal	Reinforced Teflon
End Connection	Socketwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Conbraco Industries "Apollo 83-200 Series", Contromatics "C-1122-BB-DL", Neles-Jamesbury "4000 Series", or approved equal

2.1.07 Valves VB-7.

Rating	800 psi 95.5 MPa) nonshock cold WOG
Code	ASME B16.34
Type	In-line, three piece, bolted body, regular port
Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
Trim	
Seat	Reinforced Teflon
Ball	Nickel or hard chrome plated carbon steel
Stem	Nickel or hard chrome plated carbon steel
Thrust Washer	Reinforced Teflon

Stem Seal	Reinforced Teflon
End Connection	Buttwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Contromatics "C-1133-BB-DL", or approved equal

2.1.08 Valves VB-8.

Rating	Class 600
Code	ASME B16.34
Type	In-line, three piece, bolted body, firesafe, regular port
Body/Bonnet	ASTM A105, forged steel
Trim	
Seat	Reinforced Teflon primary, metal secondary
Ball	Stainless steel
Stem	Hard chrome plated carbon steel
Thrust Washer	Reinforced Teflon
Stem Seal	Reinforced Teflon
End Connection	Socketwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Contromatics "C-1122-BB-FS"; Neles-Jamesbury "4C2236TT-1", or approved equal

2.1.09 Valves VB-9.

Rating	150 psig [1.0 MPa] nonshock cold WOG

Code	MSS SP-122
Type	In-line, true union, full port (Schedule 80)
Body/Bonnet	PVC or CPVC
Trim	
Seat	Teflon
Ball	PVC or CPVC
Stem	PVC or CPVC
Thrust Washer	Teflon
Stem Seal	Viton O-ring
End Connection	Socket
Temp. Limitations	0 to 140°F (-18 to 60°C])
Manufacturers	Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Hayward Plastic Products "True Union Ball Valve", or approved equal

2.1.10 Valves VB-10.

Rating	150 psig [1.0 MPa] nonshock cold WOG
Code	MSS SP-122
Type	In-line, true union, full port (Schedule 80)
Body/Bonnet	PVC or CPVC
Trim	
Seat	Teflon
Ball	PVC or CPVC

Stem	PVC or CPVC
Thrust Washer	Teflon
Stem Seal	Viton O-ring
End Connection	Flanged
Temp. Limitations	0 to 140°F (-18 to 60°C)
Manufacturers	Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Hayward Plastic Products "True Union Ball Valve", or approved equal

2.1.11 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.12 Rotation. The direction of rotation of the lever or handwheel to open the valve shall be to the left (counterclockwise).

2.1.13 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the Miscellaneous Ball Valve Schedule 15091-S01.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15092

INDUSTRIAL BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) industrial type butterfly valves for low-pressure air service, chemical and odor control service, hot water heating system service, and other applications where AWWA type butterfly valves are not indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Valve discs shall seat at 90 degrees with the pipe axis.

Flanged end valves shall be of the short-body type. Where mechanical joint ends are indicated in the Contract Documents, either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11 will be acceptable. For buried or submerged service, shaft seals shall be O-ring type.

2.1.01 Valves VBF-1.

Rating	Class 150
Code	MSS SP-67
Body	ASTM A395, GR 60/40/18, ductile iron
Trim	
Seat	EPDM
Disc	ASTM B148, Alloy 952, aluminum bronze
Stem	ASTM A276, Grade 316 or 304, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Upper and lower bearings or two upper bearings, bronze or reinforced teflon
Shaft Seal	Synthetic rubber O-rings
End Connection	Wafer
Temperature Limitations	-20° to 250°F (-29° to 121°C)
Manufacturers	Keystone “AR1”, or approved equal

2.1.02 Valves VBF-2.

Rating	Class 150
Code	MSS SP-67
Body	ASTM A395, GR 60/40/18, ductile iron
Trim	
Seat	EPDM
Disc	ASTM B148, Alloy 952, aluminum bronze
Stem	ASTM A276, Grade 316 or 304, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Upper and lower bearings or two upper bearings, bronze or reinforced teflon
Shaft Seal	Synthetic rubber O-rings
End Connection	Lug flanged, ASME B16.5, Class 150 diameter and drilling
Temperature Limitations	-20° to 250°F (-29° to 121°C)
Manufacturers	Keystone “AR2”, or approved equal

2.1.03 Valves VBF-3.

Rating	Class 150
Body	PVC
Trim	
Seat	FPM (Viton) or EPDM
Disc	PVC or polypropylene

Stem	AISI Type 316 stainless steel
Stem Seal	Synthetic O-rings
Shaft Bearings	Upper and lower bearings, reinforced teflon
End Connection	Flanged, ASME B16.5, Class 150 diameter and drilling
Temperature Limitations	40° to 140°F (4° to 60°C)
Manufacturers	Chemtrol “Model B”, or approved equal

2.1.04 Valves VBF-4.

Rating	Class 150
Code	MSS SP-67
Body	ASTM A395 or A536, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM A296, CF8M, stainless steel
Stem	ASTM A296, CF8M, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Acetal
End Connection	Wafer
Temperature Limitations	0° to 212°F (-18° to 100°C)
Manufacturers	ABZ “Figure 090”, or approved equal

2.1.05 Valves VBF-5.

Rating	Class 150

Code	MSS SP-67
Body	ASTM A395 or A536, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM A296, CF8M, stainless steel
Stem	ASTM A296, CF8M, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Acetal
End Connection	Lug flanged, ASME B16.5, Class 150 diameter and drilling
Temperature Limitations	0° to 212°F (-18° to 100°C)
-Manufacturers	ABZ “Figure 090”, or approved equal

2.1.06 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.07 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.08 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.

Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the Industrial Butterfly Valve Schedule 15092-S01.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Torque Tubes. Requirements for torque tubes shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.06 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15093

CHECK VALVES

PART 1 - GENERAL

1.1. SCOPE. This section covers the furnishing of check valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VC-1.

Rating	Class 150
Code	API-594
Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze
Springs/Hinge Pins/Stops	Stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 150, flat faced flanges
Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A125HZNSF", Stockham "WG-970", Mission "Duo-Chek II Figure 12HMP", Valve and Primer "9000AR1F", or approved equal

2.1.02 Valves VC-2.

Rating	Class 150
Code	API-594

Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze
Springs/Hinge Pins/Stops	Stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 150, flat faced flanges
Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A125HZNSF", Stockham "WG-970", Mission "Duo-Chek II Figure 12HMP", Valve and Primer "9000AR1F", or approved equal

2.1.03 Valves VC-3.

Rating	Class 300
Code	API-594
Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze

Springs/Hinge Pins/Stops	AISI Type 316 stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 300, raised faced flanges
Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A250HZNSR", Stockham "WG-970", Mission "Duo-Chek II Figure 25HMF", Valve and Primer "9200AR1R", or approved equal

2.1.04 Valves VC-4.

Rating	140 psig
Code	API-594
Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze or ductile iron with bronze trim
Springs, Hinge Pins & Stops	AISI Type 316 stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 300, raised faced flanges

Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A250HZNSR", Mission "Duo-Chek II Figure 25HMF", Valve and Primer "9200AR1R", or approved equal

2.1.05 Valves VC-5.

Rating	Class 125
Code	MSS SP-71, Type III, AWWA C508
Type	Horizontal swing, bolted bonnet
Body/Bonnet	ASTM A126 Class B cast iron
Trim	
Seat Ring	ASTM B763 Alloy 8440 bronze
Disc	ASTM A126, Class B, cast iron
Hinge Pins	Stainless steel
Bearings	Bronze bushings
Cover Gasket	Manufacturer’s standard
End Connection	Flanged, ASME B16.1, Class 125, flat faced
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	External spring
Manufacturers	American Flow Control "52 SC", M&H "Style 259-02", Mueller "A2600-6-02", or approved equal.

2.1.06 Valves VC-6.

Rating	Class 125

Code	MSS SP-71, Type I
Type	Horizontal swing, bolted bonnet
Body/Bonnet	ASTM A126, Class B, cast iron
Trim	
Seat Ring	Bronze
Disc	Bronze
Hinge Pins	Bronze or brass
Bushings	Bronze
Cover Gasket	Manufacturer’s standard
End Connection	Flanged, ASME B16.1 Class 125, flat faced
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	None
Manufacturers	Milwaukee "F-2974", Stockham "G-931", or approved equal

2.1.07 Valves VC-7.

Rating	Class 125
Code	MSS SP-80, Type III
Type	Horizontal swing, threaded bonnet
Body/Bonnet	ASTM B62 bronze
Trim	
Seat	Bronze, regrinding
Disc	Bronze
Hinge Pins	Manufacturer’s standard

End Connection	Threaded
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	None
Manufacturers	Stockham "B-321", Walworth "Fig 3406", or approved equal

2.1.08 Valves VC-8.

Rating	Class 125
Code	MSS SP-80, Type III
Type	Horizontal swing, threaded bonnet
Body/Bonnet	ASTM B62 bronze
Trim	
Seat	Bronze, regrinding
Disc	Bronze
Hinge Pins	Manufacturer’s standard
End Connection	Soldered
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	None
Manufacturers	Nibco "S-413-B", Walworth "Fig 3046SJ", or approved equal

2.1.09 Valves VC-9.

Rating	Class 125
Code	API-594
Type	Dual disc wafer
Body	ASTM A126, Class B, cast iron

Trim	
Seat	EPDM
Disc	Aluminum
Hinge Pins	Aluminum
Springs	Stainless steel
Bushings	Manufacturer's standard
End Connection	Plain, installed between ASME B16.1, Class 125, flat faced flanges
Temp. Limitations	-20° to 300°F (-29° to 149°C)
Valve Operator	None
Manufacturers	Techno Corporation "Technocheck Silent Seatless Check Valves", Hoffman "Air Check Valves", Lamson "Check Valves", or approved equal

2.1.10 Valves VC-10.

Rating	3000
Type	Poppet
Body	Stainless steel
Trim	
Poppet	Stainless steel
O-ring	Viton
Spring	Stainless steel
End Connection	Threaded
Temp. Limitations	-10 to 375°F [-23 to 191°C]
Valve Operator	None

Manufacturers	Circle Seal "224B" or Nupro "Series C", or approved equal.

2.1.11 Valves VC-11.

Rating	150 psig [1 MPa] nonshock
Type	Ball check, true union
Body	PVC or CPVC
Trim	
Ball	PVC or CPVC
Seat	Viton or EPDM
Seals	Viton or EPDM
End Connection	Socket
Temp. Limitations	0° to 140°F (-18 to 60°C)
Valve Operator	None
Manufacturers	Hayward Plastics Products "Ball Check Valve", Nibco "Chemtrol True Union Ball Check Valve", or approved equal.

2.1.12 Valves VC-12.

Rating	150 psig (1 MPa) nonshock
Type	Ball check, true union
Body/Bonnet	PVC or CPVC
Trim	
Ball	PVC or CPVC
Seat	Viton or EPDM
Seals	Viton or EPDM

End Connection	Flanged, ASME B16.5, Class 150, raised face
Temp. Limitations	0° to 140°F (-18° to 60°C)
Valve Operator	None
Manufacturers	Hayward Plastics Products "Ball Check Valve", Nibco "Chemtrol True Union Ball Check Valve", or approved equal.

2.1.13 <u>Valves VC-13</u>.

Rating	100 psig (690 kPa) nonshock
Type	Diaphragm, two piece
Body	PVC
Trim	
Diaphragm	Buna-N
End Connection	Threaded
Temp. Limitations	0° to 140°F (-18° to 60°C)
Valve Operator	None
Manufacturers	Plast-O-Matic "Series CK Check Valves" or "Series VB Vacuum Breakers", or approved equal

2.1.14 <u>Length Tolerance</u>. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.15 <u>Shop Coatings</u>. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

<u>Coating Materials</u>

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

<u>Surfaces To Be Coated</u>

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 <u>INSTALLATION</u>. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15094

BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of backflow preventers and associated appurtenances.

Piping, pipe supports, insulation, and accessories that are not an integral part of the backflow preventers or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each backflow preventer covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the device in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications for each unit shall include, but shall not be limited to the following:

Name of manufacturer.

Type and model.

Net weight.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

Manufacturer shall submit certification that each backflow preventer and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of backflow preventer.

Contractor shall submit results of all pressure and leakage testing.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. Backflow preventers shall be designed to meet the requirements as indicated herein and on the backflow preventer scheduleand as indicated in the Contract Documents.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Design and Construction paragraph.

2.3 DESIGN AND CONSTRUCTION. Backflow prevention device type shall be as indicated in the backflow preventer schedule and as indicated in the Contract Documents.

2.3.01 Reduced Pressure Zone Backflow Preventers. Reduced pressure zone (RPZ) backflow preventers shall consist of isolation valves, two independent check valves, and differential relief valve. The assembly shall automatically reduce the pressure in the zone between the check valves. In the event that the reduced pressure is not maintained, the differential relief valve shall open, maintaining the proper zone differential. RPZ backflow preventers shall comply with AWWA C511-92 and ASSE Standard 1013 requirements and shall be suitable for horizontal installation. Each RPZ backflow preventer shall be provided with a relief valve air-gap drain fitting.

RPZ backflow preventers in 2 inch (50 mm) and smaller sizes shall be provided with bronze bodies and with a threaded bronze bodied ball valve on each end of the device. Two inch (50 mm) and smaller RPZ backflow preventers shall be Febco “Model 860”, Cla-Val Company “Model RP6L”, Watts Regulator “Series 909”, or approved equal.

RPZ backflow preventers in 2-1/2 inch (63 mm) and larger sizes shall be provided with ductile iron bodies, epoxy-coated interior and exterior, and a flanged, resilient-seated gate valve on each end of the device. Flange diameter and drilling shall conform to ANSI/ASME B16.1, Class 125. 2-1/2 inch (63 mm) and larger RPZ backflow preventers shall be Febco “Model 860”, Cla-Val Company “Model RP7L”, Watts Regulator Company “Series 909”, or approved equal.

2.3.02 Hose Connection Vacuum Breakers. Hose connection vacuum breakers shall be provided with 3/4 inch (19 mm) hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be Watts Regulator Company “Series 8”, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15095

SOLENOID VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of solenoid operated valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Solenoid valves shall have packless construction without packing box or sliding seal.

Solenoid coils for ac service shall have voltage and frequency as indicated in the Contract Documents, encapsulated, Class F, for continuous duty at rated voltage plus or minus 10 percent and 40°C ambient, in a NEMA Type 1 or 4 enclosure, as required, with a conduit knockout.

Solenoid coils for dc service shall have dc voltage as indicated in the Contract Documents, Class H, for continuous duty at rated voltage plus or minus 10 percent and 40°C ambient, in a NEMA Type 1 or 4 enclosure as required, with a conduit knockout.

2.1.01 Valves VSOL-1.

Type	2-way, pilot operated
Body/Bonnet	Brass or bronze
Trim	
Seals	Buna-N or teflon
Disc	Buna-N or teflon
Stem	Manufacturer's standard
Bonnet Gasket	Manufacturer's standard
Spring	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	32° to 104°F (0 to 40°C)
Valve Operator	Integral
Manufacturers	ASCO "8210 Series", or approved equal

2.1.02 Valves VSOL-2.

Type	3-way, pilot operated
Body/Bonnet	Brass or bronze
Trim	
Seals	Buna-N or teflon
Disc	Buna-N or teflon
Stem	Manufacturer’s standard
Bonnet Gasket	Manufacturer’s standard
Spring	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	32° to 104°F (0° to 40°C)
Valve Operator	Integral
Manufacturers	ASCO "8316 Series", or approved equal

2.1.03 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.04 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid	Ameron "Amerlock 400 High-Solids

service)	Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 ACCESSORIES.

2.2.01 Manual Operators. Requirements for manual operators, to allow valve operation when electrical power is off, shall be as indicated in the Solenoid Valve Schedule 15095-S01.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15096

GLOBE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated, two position (open-close) globe valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VGL-1.

Rating	Class 200
Code	MSS SP-80
Type	In-line, union or threaded bonnet, rising stem, needle
Body/Bonnet	Bronze or brass
Trim	
Seat	Manufacturer’s standard
Stem	Bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	0° to 400°F (-18° to 204°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "600", Powell "Fig 180", Stockham "B-64", or approved equal.

2.1.02 Valves VGL-2.

Rating	Class 125
Code	MSS SP-80, Type 1

Type	In-line, metal disc, threaded bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Bronze
Stem	Bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	0° to 350°F (-18° to 177°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "502", Stockham "B-16", Walworth "Fig 3058", or approved equal

2.1.03 Valves VGL-3.

Rating	Class 125
Code	MSS SP-80, Type 1
Type	In-line, metal disc, threaded bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Bronze

Stem	Bronze
Bonnet Gasket	Manufacturer's standard
Stem Packing	Manufacturer's standard
End Connection	Soldered
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "1502", Stockham "B-17", or approved equal

2.1.04 Valves VGL-4.

Rating	Class 150
Code	MSS SP-80, Type 2
Type	In-line, composition disc, union bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Teflon
Stem	Bronze
Bonnet Gasket	Manufacturer's standard
Stem Packing	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	0° to 350°F (-18° to 177°C)
Valve Operator	Handwheel

Manufacturers	Milwaukee "590", Stockham "B-22T", Walworth "Fig 3095", or approved equal

2.1.05 Valves VGL-5.

Rating	Class 150
Code	MSS SP-80, Type 2
Type	In-line, composition disc, union bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Teflon
Stem	ASTM B62, bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Teflon impregnated
End Connection	Soldered
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "1590", or approved equal

2.1.06 Valves VGL-6.

Rating	Class 150
Code	MSS SP-85, Type I
Type	In-line, bolted bonnet, OS&Y rising stem

Body/Bonnet	ASTM A126 Class B, cast iron
Trim	
Seat Ring	ASTM B62, bronze
Disc	ASTM B62, bronze
Stem	Brass or silicone bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Flanged, ASME B16.1, Class 125, flat faced
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "F2981", Powell "Fig 1253", Walworth "8096F", or approved equal

2.1.07 Valves VGL-7.

Rating	Class 250
Code	MSS SP-85 Type 1
Type	In-line, single seated, top guided, bolted bonnet
Body/Bonnet	Cast iron
Trim	
Plug	316 stainless steel
Seat Ring	316 stainless steel
Stem	Manufacturer’s standard

Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Electric
Manufacturers	Dezurik “Series 1400”, or approved equal

2.1.08 Valves VGL-8.

Rating	Class 125
Code	MSS SP-85, Type 1
Type	In-line, single seated, cage, bolted bonnet
Body/Bonnet	Cast iron
Trim	
Plug	17-4 PH stainless steel
Seat Ring	17-4 PH stainless steel
Stem	Manufacturer’s standard
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Flanged, ASME B16.1, Class 125, flat faced
Temp. Limitations	0° to 350°F (-18° to 177°C)
Valve Operator	Electric
Manufacturers	Dezurik “Series 9100”, or approved

equal

2.1.09 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.10 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.11 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged,	Asphalt varnish.

or Installed in Manholes or Valve Vaults	
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coatedwith the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15097

PINCH VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated, two position (open-close) pinch valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves. Pinch valves shall be of full body construction, with flexible sleeve liner, and 100 percent port area of the joining pipe at the valve ends. The valve area shall be 100 percent of the full pipe area through the entire length of the valve. All metal parts are to be completely protected from the process fluid by a flexible elastomer liner. Each valve shall be throttled and fully closed with compressed air that constricts the sleeve at the center of the valve. Each valve body shall be drilled and tapped for a pressure connection on top and bottom of the housing.

The elastomer liners shall be manufactured from elastomer with polyester reinforcement ply and with flanges. Metal reinforcements in valves sized 6 inches (150 mm) and larger shall be molded into the liner flanges. The elastomer liner shall be pre-pinched and shall be field replaceable. Two piece liners shall be identical and shall lock into position without separate gaskets or adhesives. The metal body shall consist of two identical halves.

The calculated bursting pressure of the elastomer liner shall be four times the rated working pressure of the valve. The valve shall be able to handle surge pressures of 150 percent of the working line pressure without breakage.

Rating	Class 150
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Liner	Buna-N
End Connection	Flanged, ASME B16.5, Class 150, flat faced
Temp. Limitations	40 to 225°F (4 to 107°C)
Valve Operator	Integral, pneumatic
Manufacturers	Fowler “Delta Series”, or approved equal

2.1.02 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.03 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15098

PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated, two position (open-close) plug valves for the services as indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VP-1.

Rating	175 WOG
Code	
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Plug Seal	Hycar
Plug	Bronze or nickel plated cast iron
Stem Seal	Buna
End Connection	Threaded
Temp. Limitations	-20 to 180°F (-29 to 82°C)
Valve Operator	Lever
Manufacturers	Key Port "Fig 425-RS51", or approved equal

2.1.02 Valves VP-2.

Rating	175 WOG
Code	
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Plug Seal	Hycar
Plug	Bronze or nickel plated cast iron

Stem Seal	Buna
End Connection	Flanged, ASME B16.1, Class 125
Temp. Limitations	-20 to 180°F (-29 to 82°C)
Valve Operator	Lever
Manufacturers	Key Port “Fig 425-RS51”, or approved equal

2.1.03 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.04 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.05 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coatedwith the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15099

PRESSURE REDUCING VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of pressure reducing valves for gas, air, and water service as indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.

Type and model.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. Pressure reducing valves shall be designed to meet the requirements as indicated herein and on the Pressure Reducing Value Schedule 15099-S01 and as indicated in the Contract Documents.

Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2.3 MATERIALS. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel (NSF certified)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", approved equal; immersion service.
Epoxy Enamel (Natural Gas Service)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series N69 Hi-Build Epoxoline II", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.

2.4 CONSTRUCTION.

2.4.01 Water Service. Pressure reducing valves for water service shall be direct-acting or pilot-operated type as indicated in the Pressure Reducing Valve Schedule.

Direct-acting valves shall be globe type with threaded connections and union assembly. The valves shall be provided with bronze body and cover, stainless steel trim, reinforced neoprene diaphragm, Buna-N disc, and stainless steel strainer. Direct-acting pressure reducing valves shall be Cla-Val “Model 990”, Cash-Acme, Watts, or approved equal.

Pilot-operated valves shall be globe type with flanged ends. The valves shall be provided with epoxy coated ductile iron body, bronze trim, and Buna-N rubber diaphragm and disc. The pilot regulating valve shall be bronze with stainless steel trim. Pilot-operated pressure reducing valves shall be Cla-Val “Model 990”, Cash-Acme, Watts, or approved equal.

When indicated in the schedules, pilot-operated valves shall be equipped with a low flow bypass. The low flow bypass shall consist of a direct-acting pressure reducing valve in parallel with the pilot-operated valve. The valves and required piping assembly shall be factory assembled and shall be Cla-Val “Model 90-48”, or approved equal.

2.4.02 Gas Service. Pressure reducing valves for natural gas and propane gas service shall be suitable for gases with specific gravities of 0.6 and 1.5, respectively. Natural gas and propane gas pressure reducing valves shall be direct-acting type with cast iron or cast steel bodies, threaded ends, aluminum trim, and a nitrile diaphragm and disc. Valves shall be Fisher Controls "S-102/S-201 Series", or approved equal.

Pressure reducing valves for digester gas service shall be suitable for gas with specific gravity of 0.8 to 0.9. Digester gas pressure reducing valves shall be pilot-operated type with stainless steel bodies, stainless steel trim, viton diaphragm, and stainless steel pilot. Valves shall be Fisher Controls "1098-EGR Series", or approved equal.

2.4.03 Air Service. Pressure reducing valves for air service shall have a cast iron or steel body with stainless steel trim and a composition disc. Pressure reducing valves shall be furnished with integral or line mounted inlet filters/strainers and discharge pressure gauges. Valves shall be as manufactured by Fisher Controls; Jordan Valve Div., Richards Industries; O. C. Keckley Co.; Leslie Controls, Inc.; Spirax Sarco, Inc; or approved equal.

2.5 SHOP COATING. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Surfaces to be Coated

Interior Surfaces	
Liquid Service	Epoxy (NSF certified).
Fuel Gas and digester Gas Service	Epoxy.
Exterior Surfaces	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15100

MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous valves as indicated in the Contract Documents. This section includes the following types of valves:

Hose faucets
Wall hydrants
Wall hydrants with vacuum breaker
Yard hydrants
Post type yard hydrants
Curb stops

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment , Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications, covering the valves and their appurtenances shall be submitted in accordance Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180,Equipment , Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.02 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.03 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 HOSE VALVES AND HYDRANTS.

2.2.01 Hose Faucets, VHF-1.

Type	Faucet, threaded bonnet
Body/Bonnet	Brass
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, male NPT x male HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	T-handle
Manufacturers	Chicago Faucets "No. 7T", Tanner "1235", or approved equal

2.2.02 Wall Hydrants, VHF-2.

Type	Freeze proof
Body/Bonnet	Brass or bronze
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, NPT x male HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	Removable key
Manufacturers	Josam "71200", Smith "5610", Wade "W-8604", Woodford "60", Zurn "Z-1315", or approved equal

2.2.03 Wall Hydrants with Vacuum Breaker, VHF-3.

Type	Freeze proof, with vacuum breaker
Body	Brass or bronze
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, NPT x male HPT
Temp. Limitations	32° to 212°F (0° to 100°C)

Valve Operator	Removable key
Manufacturers	Josam "71050", Smith "5609", Wade "W-8620", Woodford "65", Zurn "Z-1310", or approved equal

2.2.04 Yard Hydrants, VHF-4.

Type	Non-freeze, box type
Body	Brass or bronze
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
Box, Cover, Casing	Bronze
End Connection	Threaded, NPT x HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	Removable key
Manufacturers	Josam "Series 71600", Smith "5810/5813", Wade W-8610", Zurn "Z-1360/1365", or approved equal

2.2.05 Post Type Yard Hydrants, VHF-5.

Type	Non-freeze, post type
Body	Brass or bronze
Trim	
Seat	Manufacturer’s standard

Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, NPT x HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	Removable key
Manufacturers	Josam "Series 71701", Smith "5910/5913", Wade "W-8604", Woodford "60", Zurn "Z-1385/1390", or approved equal

2.3 CURB STOPS.

2.3.01 Curb Stops, VCS-1.

Code	AWWA C800
Type	Straight-through
Body	Brass or bronze
Trim	
Seat	Manufacturer's standard
Plug/Ball	Manufacturer's standard
Stem	Manufacturer's standard
Stem Seal	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	T-handle
Manufacturers	Ford Meter Box "Ford Ball Valve", Hays "Nuseal Curb Stop", Mueller

"Mark II Oriseal", or approved equal

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5 ACCESSORIES.

2.5.01 Extension Stems. Requirements for extension stems and stem guides shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.03 Floor Boxes. Requirements for floor boxes shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.04 Operating Stands. Requirements for operating stands shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. When specified herein, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section01180, Equipment, Materials, Parts, and Tools and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated, as in accurate alignment, is free from any undue stress imposed by connecting piping and appurtenances, and has been operated under full load conditions and that is operated satisfactory.

3.2 SCHEDULE. See Schedules 15100-S01 and 15100-S02.

End of Section

SECTION 15101

AWWA BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of AWWA butterfly valves for cold water service as indicated in the Contract Documents and AWWA Butterfly Valve Schedule 15101-S01. All other butterfly valves are covered in Master Specification Section 15092, Industrial Butterfly Valves.

AWWA butterfly valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all butterfly valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C504.

1.2.03 Marking. Supplementing the requirements of Section 6.1 of the governing standard, the country of origin of all castings and an identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

1.2.04 Temporary Number Plates. Each butterfly valve shall be tagged or marked in the factory with the identifying number listed in the AWWA Butterfly Valve Schedule 15101-S01.

1.2.05 Permanent Number Plates. All butterfly valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall

be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Certified copies of test results as specified herein by Section 5 of ANSI/AWWA C504, with an affidavit of compliance as indicated in Section 1.7 of C504, shall be submitted to Engineer before the valves are shipped. Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS. Butterfly valves shall be limited to the manufacturers as specified herein. Sizes and styles for the manufacturers shall be limited as indicated, without exception:

Manufacturer	Acceptable Sizes and Styles
Rodney Hunt	All
Val-Matic	All
Milliken	All
DeZurik	All

Pratt	All
M&H	All

2.2 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of butterfly valves shall conform to the requirements of ANSI/AWWA C504.

Acceptable shop coatings are listed in the following table.

Asphalt Varnish	Fed. Spec. TT-C-494.
Epoxy Enamel (NSF certified systems)	Ameron “Amerlock 400 High-Solids Epoxy Coating”, Carboline “Carbogard 891”, Tnemec “Series N140 Pota-Pox Plus”, or approved equal, immersion service.
Epoxy Enamel (non-NSF certified)	Ameron “Amercoat 385 Epoxy”, Carboline “Carbogard 890”, Tnemec “Series 69 Hi-Build Epoxoline II”, or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Bodies. Valves shall be ductile iron, short-body type except where wafer type is specified in the AWWA Butterfly Valve Schedule 15101-S01. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable.

The valve disc shall be a single casting made of ductile iron with a dome shape.

2.3.02 Flanges. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 μm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (0.017 percent) of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2.3.03 Mechanical Joint Ends. Mechanical joint ends shall be either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11.

2.3.04 Valve Shafts. Valve shafts shall be fabricated of AISI Type 17-4PH stainless steel. The use of shafts having a hexagonal cross section will not be acceptable. Shafts shall be provided with a permanent indicating mark to identify disc position when the actuator is removed or reinstalled.

The connection between the shaft and the disc shall be mechanically secured by means of solid, smooth sided, stainless steel or monel taper pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of set screws, knurled or fluted dowel pins, expansion pins, roll pins, tension pins, spring pins, or other devices instead of the pins specified herein will not be acceptable.

2.3.05 Valve Seats. Acceptable seating surfaces mating with rubber are AISI Type 316 stainless steel, or monel for all valves; bronze for 20 inch (500 mm) and smaller valves.

Seats shall be located on the valve body or disc as required. Valve seat configurations which rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.

The valve seat shall be natural rubber or Buna-N that is certified compliant with NSF 61.

2.3.06 Shaft Seals. The valve shall be provided with a ductile iron stuffing box at the projection of the valve shaft from the valve body. Stuffing boxes for rectangular section packing shall be bushed in an approved manner with bushings made of cast bronze or type 316 stainless steel. Stuffing boxes for “vee” type packing shall be fitted with a cast bronze or type 316 stainless steel bottoming ring.

The stuffing box gland and follower, gland studs and nuts shall be manufactured of cast bronze bronze or type 316 stainless steel. The follower shall be of split construction.

The stuffing box shall be packed with graphited, non-asbestos, rectangular packing or Engineer approved “vee” type packing.

2.3.07 Thrust Bearings. Each valve shall be provided with one or more thrust bearings in accordance with the governing standard. Thrust bearings which are directly exposed to line liquid and which consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable.

2.3.08 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified herein, as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the AWWA Butterfly Valve Schedule 15101-S01.

All 8 inch (200 mm) and larger valves shall have geared actuators.

If valves with an AWWA class designation higher than indicated in the schedule are furnished, actuator torque capabilities shall be increased accordingly and be acceptable to Engineer.

2.4.01 Actuator Sizing. The valve manufacturer shall size the actuator in accordance with AWWA C504, the operating conditions and requirements indicated in the AWWA Butterfly Valve Schedule 15101-S01, and the valve manufacturer's requirements.

For valves 20 inch (500 mm) and smaller, the actuator torque shall be at least 70 percent of the AWWA C504 Table 4 torque for Class 150B. For valves 24 inch (600 mm) and larger, the actuator torque shall be at least 50 percent of the Table 4 torque for the AWWA class valve being provided.

For valves with actuator torque requirements not indicated shall have an actuator torque based on a maximum differential pressure across the valve equal to the valve class and a maximum velocity through the valve of 16 feet per second (4.9 m/s).

Valves with operating stands shall have actuator torques increased by 25 percent. Actuator torques determined by the above requirements shall be increased by any safety factors required by AWWA C504, paragraphs 3.8.6.1 and 3.8.7 or indicated or specified herein.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting. Coal tar shall not be an acceptable coating.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy enamel.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.

Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy Enamel	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.05 Torque Tubes. Requirements for torque tubes shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.06 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.7 SHOP TESTING. Except as modified herein, AWWA butterfly valves shall be tested in accordance with Section 5 of AWWA C504. Each valve shall be performance tested in accordance with Section 5.2.1 and shall be given a leakage test and a hydrostatic test as described in Sections 5.2.2 and 5.2.3.
Each valve shall be leaktight in both directions when closed by the actuator with the maximum pressure applied to the valve.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.
3.2 SCHEDULE. See the Butterfly Valve Schedule 15101-S01.

End of Section

SECTION 15102

ECCENTRIC PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of eccentric plug valves as indicated in the Contract Documents and Eccentric Plug Valve Schedule 15102-S01.

Plug valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Marking. Each valve shall be marked with the manufacturer's name, valve size, and pressure rating, and the country of origin of the body casting. All markings shall be cast on the exterior surface of the valve body. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

1.2.03 Temporary Number Plates. Each eccentric plug valve shall be tagged or marked in the factory with the identifying number listed in the Eccentric Plug Valve Schedule 15102-S01.

1.2.04 Permanent Number Plates. All plug valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate oras indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance withMaster

Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Certified copies of reports covering proof-of-design testing of valves as set forth in Section 5.2 of ANSI/AWWA C504, with an affidavit of compliance as indicated in Section 1.7 of C504, shall be submitted to Engineer before the valves are shipped. Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS. Eccentric plug valves furnished under this section shall be manufactured by DeZurik, Pratt, Milliken, Val-Matic, Clow, or Victaulic, without exception.

2.2 MATERIALS. Materials used in the manufacture of eccentric plug valves shall be as indicated:

Body	Ductile iron, ASTM A536, Grade 65-45-12.
Plug	Ductile iron, ASTM A536, Grade 65-45-12.
Plug Facing	Neoprene or Buna-N, 70 Type A durometer hardness in accordance with ASTM D2240.
Body Seat	Welded nickel overlay.
Upper and Lower Trunnion Bearings	Sleeve type; type 316 stainless steel or bronze.
Upper Thrust Bearing	TFE, Nylatron, or Delrin.

Stem Seal	V-type packing or U-cups, Buna-N or TFE.

Acceptable shop coatings are listed in the following table. Whenindicated on the Contract Documents, epoxy for liquid service shall be as specified in Master Specification Section 09900, Painting rather than as indicated below.

Asphalt Varnish	Fed Spec TT-C-494.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Epoxy	
For Gas Service	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", Plasite "Plasguard 7122", or approved equal.
For Liquid Service	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Body. The valve port area of each valve shall be at least 80 percent of the cross section of the connecting piping for 20 inch (500 mm) and smaller valves and 70 percent for 24 inch (600 mm) and larger valves. Valves shall provide tight shutoff at the rated pressure from either direction. An adjustable closed position plug stop shall be provided.

Each valve body shall be plainly marked to indicate the seat end. The actual length of 10 inch (250 mm) and smaller valves shall be within plus or minus 1/16 inch (1.6 mm) of the theoretical length. The actual length of 12 inch (300 mm) and larger valves shall be within plus or minus 1/8 inch (3 mm) of the theoretical length.

Valve ends shall be compatible with connecting piping. All valves shall have flanged, grooved or mechanical joint ends as indicated in the Eccentric Plug Valve Schedule 15102-S01. Flange diameter and drilling shall be spot faced and conform to ANSI B16.1, Class 125. Flanges shall be flat faced and finished to true plane surfaces within a tolerance limit of 0.005 inch (0.12 mm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of

0.002 inch per foot (0.16 mm per meter) of flange diameter. The degree of smoothness of the flange faces shall be 125 RMS.

Grooved end dimensions shall conform to AWWA C606, Table 5, for rigid joints. When grooved end valves are to be installed in flanged piping, two flange adapters compatible with the connecting piping shall be provided with each valve. Mechanical joint ends shall conform to ANSI/AWWA C111/A21.11.

Valve bodies shall be rated for a working pressure as indicated on the Eccentric Plug Valve Schedule 15102-S01.

2.3.02 Plug. The plug shall be of one-piece construction and shall have a cylindrical or spherical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and the body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug surfaces shall be faced with a resilient material.

2.3.03 Seats. Seats shall be cast in the body and shall have raised, welded-in nickel overlay not less than 0.050 inch (1.30 mm) thick on all surfaces in contact with the plug face. The overlay shall be at least 90 percent nickel and have a Brinell hardness of 200 or greater.

2.3.04 Stem Seals. The valve shaft shall be sealed by U-cups or by at least four self-adjusting chevron type packing rings.

2.3.05 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified herein, as specified in Master Specification Section 15180, Valve and Gate Actuators and as indicated in the Eccentric Plug Valve Schedule 15102-S01.

Geared actuators shall be used for manually operated valves in the following applications:

1. For all 4 inch (100 mm) and larger buried valves.

2. For all 8 inch (200 mm) and larger valves.

3. For all 6 inch (150 mm) valves in throttling or free discharge applications.

4. For all 6 inch (150 mm) valves where the unseating pressure exceeds

25 psi (170 kPa).

5. For all chainwheel operated valves.

6. For all valves in gas service.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valves and accessories, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	
For Liquid Service	Epoxy.
For Gas Service	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

When specified herein, interior epoxy coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.7 TESTING. Except as modified herein, eccentric plug valves shall be tested in accordance with Section 5 of AWWA C504. Each valve shall be performance tested in accordance with Section 5.2.1 and shall be given a leakage test and a hydrostatic test as described in Sections 5.2.2 and 5.2.3. The leakage test shall be applied to the seating face of the plug (tending to unseat the plug) at the rated pressure of the valve.

Each valve shall be leaktight in both directions when closed by the actuator with the maximum differential pressure applied to the plug as specified in the Eccentric Plug Valve Schedule 15102-S01.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.2 SCHEDULE. See the Eccentric Plug Valve Schedule 15102-S01.

End of Section

SECTION 15103

AWWA BALL VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of 6 inch (150 mm) and larger AWWA ball valves as indicated in the Contract Documents and AWWA Ball Valve Schedule 15103-S01. Four inch (100 mm) and smaller ball valves are covered in Master Specification Section 15091, Miscellaneous Ball Valves.

AWWA ball valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all ball valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C507.

1.2.03 Temporary Number Plates. Each ball valve shall be tagged or marked in the factory with the identifying number listed in the AWWA Ball Valve Schedule 15103-S01.

1.2.04 Permanent Number Plates. All ball valves shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch [25 mm] high and shall be black baked enamel on anodized aluminum plate or shall be asindicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Certified copies of reports covering proof-of-design testing of valves as set forth in Section 5.2.4.3 of ANSI/AWWA C504, with an affidavit of compliance as indicated in Section 1.3 of C507, shall be submitted to Engineer before the valves are shipped. Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS. Ball valves shall be as manufactured by APCO/Williamette, Valve Technologies, or approved equal.

2.2 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of ball valves shall conform to ANSI/AWWA C507.

Shop Coatings

Epoxy (NSF certified systems.	Ameron "Amerlock 400 High-Solids Epoxy Coating"; Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox plus", or approved equal; immersion service.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Body. Each valve body shall be ductile iron and provided with flanged ends. Flanges shall be flat faced and finished to true plane surfaces within a tolerance of 0.005 inch (0.12 mm). Each flange face shall be perpendicular to the longitudinal axis of the valve, within a maximum angular variation tolerance of 0.002 inch per foot (0.16 mm/m) of flange diameter. Flange faces shall have concentric or spiral serrated finish.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125.

Actual length of valves shall be within plus or minus 1/16 inch (1.6 mm)of the theoretical length.

2.3.02 Ball. Each ball shall be designed so that there will be flow between the ball and body when the ball is in a throttled position and so that substantially all flow is through the ball when in the fully open position.

2.3.03 Seats. The type of seats shall be metal to metal, as specified herein. For metal-to-metal seated valves, a type 316 stainless steel seat shall be provided on the ball and a monel seat on the valve body. The ball shall be fitted with a type 316 stainless steel sleeve and the ball seat shall be attached to this sleeve by a threaded connection. Valve seats shall be located as specified herein. The seats and the type 316 stainless steel sleeve shall be securely anchored in place.

Contact pressure between seats shall not exceed 1,000 psi (6895 kPa) at an unbalanced head equal to the specified working pressure.

2.3.04 Operating Mechanism. Unless otherwise specified, the basic operating mechanism for each valve shall be of the traveling-nut type and shall consist of (1) a traveling crosshead which will move transversely to the valve shaft, (2) a threaded lead screw engaging corresponding threads in the crosshead, which will move the crosshead when turned by the valve drive unit for manual or electric motor operated valves, and a piston rod with the crosshead directly attached thereto for cylinder operated valves, and (3) a rotator lever, linked to the crosshead, which will impart a rotary motion to the valve shaft. Worm gear type operating mechanisms will also be acceptable for electric motor operated valves. The operator shall have manual stops.

2.3.05 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the AWWA Ball Valve Schedule 15103-S01.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy (NSF 61 certified).
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the AWWA Ball Valve Schedule 15103-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the AWWA Ball Valve Schedule 15103-S01, and as specified in Section Master Specification 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the AWWA Ball Valve Schedule 15103-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators

2.7 PROOF-OF-DESIGN TESTING. Except as modified or supplemented herein, ball valves shall be subject to proof-of-design testing in accordance with Section 5.2.4.3 of ANSI/AWWA C504 titled Rubber-Seated Butterfly Valves. Upon completion of the cycle test, seat leakage of metal-seated valves shall not exceed the rate set forth in Section 5.2.2.1 of ANSI/AWWA C507, and resilient-seated valves shall be droptight.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.
3.2 SCHEDULE. See AWWA Ball Valve Schedule 15103-S01.

End of Section

SECTION 15104

RESILIENT-SEATED GATE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of resilient-seated AWWA gate valves for water service as indicated in the Contract Documents and Resilient-Seated Gate Valve Schedule 15104-S01.

Resilient-seated gate valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all resilient-seated gate valves shall conform to the applicable requirements of ANSI/AWWA C509.

1.2.03 Marking. Supplementing the requirements of Section 7.1 of the governing standard, the name of the country where the valve body was manufactured shall be cast on the exterior of the body. The name of the country where the gate was manufactured shall be molded into the resilient seat material.

1.2.04 Temporary Number Plates. Each resilient-seated gate valve shall be tagged or marked in the factory with the identifying number listed in the Resilient Seated Gate Valve Schedule 15104-S01.

1.2.05 Permanent Number Plates. All gate valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall

be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

All valves shall be tested in accordance with Section 6 of ANSI/AWWA C509. Certified copies of the results of all tests, together with an affidavit of compliance as indicated in Section 1.5, shall be submitted to Engineer before the valves are shipped.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of resilient-seated gate valves shall conform to the requirements of ANSI/AWWA C509.

2.1.01 Bronze Components. All bronze valve components in contact with liquid shall contain less than 15 percent zinc. All aluminum bronze components in contact with liquid shall be heat treated in accordance with Section 2.2 of ANSI/AWWA C504 to inhibit dealuminization.

2.1.02 Gaskets. Gaskets shall be free of asbestos and corrosive ingredients.

2.1.03 Shop Coatings.

Asphalt Varnish	Fed Spec TT-C-494.

Epoxy (NSF Certified)	Manufacturer's standard fusion-bonded or liquid epoxy.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.2 VALVE CONSTRUCTION.

2.2.01 Body. Valve shall be fabricated of ductile iron.

2.2.02 Ends. Valve ends shall be compatible with connecting piping and as indicated in the Resilient Seated Gate Valve Schedule 15104-S01. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of ANSI/AWWA C509.

Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 μm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.001 inch per inch (1 μm/mm) of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2.2.03 Stem Seals. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems. The type of stem shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01.

2.2.04 Rotation. The direction of rotation of the handwheel or the wrench nut to open the valve shall be to the left (counterclockwise).

2.2.05. Shop Coating. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. Except as specified below, the valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be coated as follows:

Interior surfaces	Epoxy (NSF certified)
Exterior surfaces of all other valves.	Universal primer.
Polished or machined surfaces.	Rust-preventive compound.

The protective epoxy coating on the interior surfaces of each valve shall be applied in three coats, with a minimum total dry film thickness of 13 mils (325 μm). Alternatively, the manufacturer's standard coating may be used and the interior surfaces of each valve shall be subjected to a nondestructive holiday test in accordance with ASTM G62, Method A, and shall be electrically void-free.

Interior coatings shall comply with AWWA C550. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils (250 μm) or 13 mils (325 μm)where specified herein.
Universal Primer	3 mils (75 μm)

2.3 VALVE ACTUATORS. Requirements for valve actuators shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4 ACCESSORIES.

2.4.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.02 Floor Boxes. Requirements for floor boxes shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.03 Operating Stands. Requirements for operating stands shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.04 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves shall be handled and installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.2. SCHEDULE. See the Resilient-Seated Gate Valve Schedule 15104-S01.

End of Section

SECTION 15105

DOUBLE DISC GATE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of 3 inch (75 mm) and larger double disc, parallel seat gate valves for water service as indicated in the Contract Documents and Double Disc Gate Valve Schedule 15105-S01.

Double disc gate valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production and valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all double disc gate valves shall conform to the applicable requirements of AWWA C500.

1.2.03 Marking. Supplementing the requirements of Section 6.1 of the governing standard, each gate valve shall be marked with the maximum working pressure for which the valve is designed. In addition, the name of the country where the valve body was manufactured shall be cast on the exterior of the body.

1.2.04 Temporary Number Plates. Each double disc gate valve shall be tagged or marked in the factory with the identifying number listed in the Double Disc Gate Valve Schedule 15105-S01.

1.2.05 Permanent Number Plates. All gate valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall

be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

All valves shall be tested in accordance with Section 5.2 of AWWA C500. Certified copies of the results of all tests, together with an affidavit of compliance as indicated in Section 1.4, shall be submitted to Engineer before the valves are shipped. Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of double disc gate valves shall conform to the requirements of ANSI/AWWA C500.

2.1.01 Bronze Components. All bronze valve components in contact with liquid shall contain less than 15 percent zinc. All aluminum bronze components in contact with liquid shall be heat treated in accordance with Section 2.2 of ANSI/AWWA C504 to inhibit dealuminization.

2.1.02 Gaskets. Gaskets shall be free of asbestos and corrosive ingredients.

2.1.03 Shop Coatings.

Epoxy Enamel (NSF certified)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal; immersion service.

Epoxy Enamel (non-NSF certified)	Ameron "Amerlock 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.2 VALVE CONSTRUCTION.

2.2.01 Body. Valve shall be fabricated of ductile iron.

2.2.02 Ends. Valve ends shall be compatible with connecting piping and as indicated in the Double Disc Gate Valve Schedule 15105-S01. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of ANSI/AWWA C500.

Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 µm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (165 µm/m) of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2.2.03 Stem Seals. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems. The type of stem shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01.

2.2.04 Rotation. The direction of rotation of the handwheel or wrench nut to open the valve shall be to the right (clockwise).

2.2.05 Bypasses. All 16 inch (400 mm) and larger gate valves shall be provided with a bypass and a bypass valve. Bypasses and bypass valves shall comply with Section 3.20 and Table 8 of the governing standard.

2.2.06 Gearing. All 16 inch (400 mm) and larger gate valves shall be provided with gears and gear cases as indicated in the Double Disc Gate Valve Schedule 15105-

S01. Gears and gear cases shall comply with Sections 3.17 and 3.18 and Table 7 of the governing standard.

2.2.07 Internal Rollers and Tracks. All 16 inch (400 mm) and larger valves installed in horizontal piping with the stem oriented horizontally shall be equipped with internal rollers and tracks, as indicated in the Double Disc Gate Valve Schedule 15105-S01.

2.2.08 Shop Coating. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be coated as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy enamel (NSF certified for potable water service).
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.
Actuators and Accessories	Universal primer.

Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness

Epoxy Enamel	10 mils (250 µm)
Universal Primer	3 mils (75 µm)

2.3 VALVE ACTUATORS. Requirements for valve actuators shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4 ACCESSORIES.

2.4.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.02 Floor Boxes. Requirements for floor boxes shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.03 Operating Stands. Requirements for operating stands shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.04 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.2 SCHEDULE. See the Double Disc Gate Valve Schedule 15105-S01.

End of Section

SECTION 15106

CONE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of cone valves for the services indicated in the Contract Documents and Cone Valve Schedule 15106-S01.

Cone valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Temporary Number Plates. Each cone valve shall be tagged or marked in the factory with the identifying number listed in the Cone Valve Schedule 15106-S01.

1.2.03 Permanent Number Plates. All cone valves shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Fluid diagrams for all hydraulic systems shall be submitted. Diagrams shall be drawn using fluid power symbols approved by the American National Standards Institute, Inc., or the manufacturer's standard set of symbols if these symbols adequately and clearly explain the operation of the various components.

In addition, the following drawings shall be submitted before fabrication of the valve control equipment for the pump check valves:

> Curve plotting "Area of Opening in Percent of Full Opening" versus "Plug Rotation in Degrees".
>
> Curve plotting "Area of Opening in Percent of Full Opening" versus "Time of Valve Closure" for normal closing.
>
> Curve plotting "Area of Opening in Percent of Full Opening" versus "Time of Valve Closure" for emergency closing.

When requested by the Engineer, certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components. Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 <u>ACCEPTABLE PRODUCTS</u>. Cone valves shall be manufactured by Rodney Hunt, American Valve (Pennsylvania), or approved equal.

2.2 <u>MATERIALS</u>. Materials used in the manufacture of the cone valve as furnished, and of all valve accessories, appurtenances, and control equipment and devices, shall be new and the best and most suitable for the purpose intended in each case, the selection of each such material being based on strength, ductility, durability, and other basic properties in accordance with the best current engineering practice. Materials shall conform to the latest applicable standards of the American Society for Testing and Materials.

Materials used in the manufacture of the cone valve shall be as follows:

Body	Ductile iron, ASTM A536 Grade 65-45-12.
Plug	Ductile iron, ASTM A536, Grade 65-45-12.
Body Seats	Monel.
Plug Seats	Monel.
Bearings	Bronze.
Plug Shaft	Stainless steel, AISI Type 17-4PH w/minimum tensile strength of 80,000 psi.
Operating Mechanism	Cast steel, ASTM A27; or ductile iron, ASTM A536.
Shaft Packing	Graphite packing with split lantern ring/gland. Provide special tools necessary for packing replacement.
Shop Coatings	
Epoxy Enamel	NSF certified systems; Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Universal Primer	Universal Rust-Inhibitive Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 888 Primer," or Tnemec Series N27 S.T. Typoxy.
Rust-Preventive Compound	Houghton "Rust Veto 344".

All materials subject to rubbing contact shall be of different hardness to prevent galling. Difference in hardness between the two surfaces shall be at least 125 Brinell.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Body. The body of the valve shall be ductile iron and shall have flanged inlet and outlet waterway openings and a flanged opening for insertion or removal of the valve plug.

Both inlet and outlet ends of the valve body shall be provided with seat rings fused into the body metal, with the seat faces raised above adjacent body surfaces by a sufficient amount to assure free operation of the valve plug regardless of any encrustations on interior body surfaces.

Each valve shall be provided with four NPT taps with solid brass plugs, two located on each side of the valve. The size of the taps shall be determined by the Owner based on the size of the valve.

2-3.02 Flanges. The valve shall be provided with end flanges conforming to ANSI/ASME B16.1, Class 250.

Flanges shall be flat faced and finished to true plane surfaces within a tolerance limit of 0.005 inch. Each finished face shall be perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2-3.03 Plug. The plug shall be in the form of a frustrum of a cone, with a clear circular-section waterway. The plug shall rotate on large diameter end trunnions made of magnesium bronze with a tensile strength of 70,000 psi, and shall be provided with bronze bearing sleeves operating in bronze-bushed bearings in both valve body and valve-head cover. The clearances between bearing sleeves and the bearings shall not exceed 0.008 inches. The maximum allowable unit bearing stress shall not exceed 3,000 psi. The valve operating shaft shall be provided with either a hard bronze sleeve or a chrome overlay where it passes through the valve-head cover stuffing box.

The plug shall be provided with four seat rings fused into the plug metal, one each around the inlet and the outlet plug openings, and the other two placed at right angles thereon so as to cut off the flow when the valve is in a closed position. The plug and seats shall be designed for only an axial motion for unwedging the seated pair of the plug seats from the body seats and of a rotary motion for turning the plug 90 degrees and aligning the second pair of seats in the plug with the body seats, followed only by axial motion during seating. Seats shall not be in contact with any part of the valve at any time during rotation of the plug. Body seats and their mating plug seats shall be machined to close tolerances, so as to fully mate to reduce wear and minimize leakage when the cone pump check valve is fully opened or closed.

The plug seats shall have a minimum thickness of 0.090 inches after fusing and machining.

2.3.04 Valve-Head Cover. The valve shall be provided with a valve-head cover casting which will (a) close the flanged head opening in the valve body, (b) support the outer plug trunnion and attached shaft, and (c) support the valve operating mechanism and mechanism housing. The valve head cover shall be arched in the center to allow water from the packing gland or other external source to drain freely off the valve. The valve-head cover shall make a registered connection with the valve body and shall be provided with a bronze-bushed bearing, shaft stuffing box, split bronze packing gland, suitable graphite packing, and four jacking bolts equally spaced around the perimeter for removal. Head bolts, studs, and nuts shall be of silicon bronze. Reference match marks shall be provided on both body and valve-head cover to ensure proper assembly.

The stuffing box shall have sufficient depth for the graphite packing and to contain a portion of the gland. The packing shall be replaceable without removing the valve actuator. The gland shall be bronze, split, drilled, threaded and pinned. It shall be easily accessible, adjustable via bronze studs and double nuts with one nut being a locking nut. The valve actuator shall not be used to retain the shaft seal.

2.3.05 Operating Mechanisms. The basic valve operating mechanism shall consist of (a) crosshead which will move in a straight line between parallel guide rods transversely to the plug shaft, (b) a piston rod which will transmit an operating force from the drive unit to the crosshead, (c) a lift lever which will impart a rotary motion to the plug shaft. The operating mechanism shall provide for axial adjustment of the plug to compensate for any wear that may develop. The plug operating shaft shall be of sufficient strength to withstand any stresses to which it may be subjected under the most adverse operating conditions. Pipe stops are required in the open position.

Valve operation shall be such that 10 percent opening area of the plug waterway will be obtained when the crosshead travels between 45 and 55 percent of its total linear movement.

Crosshead, lift nut and other parts of the operating mechanism shall be greasable from the outside of the mechanism housing.

The valve operating mechanism shall be totally enclosed in a suitable housing with a removable cover which will permit inspection, adjustment, and repair of the operating mechanism.

2.3.06 Valve Position Indicators. An indicating pointer, attached to a plug shaft extension through and operating over an indicator plate mounted on the operating mechanism housing cover, shall be provided to indicate the position of the plug opening relative to the body seat openings. The indicating pointer shall be both bolted and pinned to the plug shaft extension to ensure alignment.

Indicator plates shall be graduated to show percentages of both projected port area and plug rotation.

2.3.07 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.3.08 Valve Base. Cone valves shall be provided with a base or pedestal for support. Cone valves shall be supported upon a steel bearing plate anchored into a concrete support as indicated on the Drawings. Contact surfaces of valve body and bearing plate shall have milled finishes, and the valve shall be free to move upon the bearing plate. Bolting of the valve to base will not be acceptable.

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the Cone Valve Schedule 15106-S01.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in Master Specification Section 09900, Painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy Enamel	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

PART 3 - EXECUTION

3.1 HYDROSTATIC TESTS. Each valve shall be fully assembled in the shop prior to testing. Test heads shall be bolted to each waterway flange and, with the plug in a partially open position, each valve shall be tested hydrostatically at a test pressure equal to 150 psi greater than the valve working pressure. This test pressure shall be maintained for 30 minutes, and the valve shall show no evidence of structural failure, seeps, or leakage at any point.

The valve shall also be tested for leakage, with one test head removed and the plug closed. A test pressure equal to the valve working pressure shall be applied and maintained for 15 minutes, during which time the leakage through the valve shall not exceed 0.15 ounce per minute per inch of valve waterway diameter. The test should then be repeated with the pressure applied to the opposite side of the valve.

After complete assembly, the valve shall be opened and closed at least twice.

Cone valve operator controls shall be shop tested for proper operation prior to shipment.

3-1.01 Witness Testing. Representatives from both the Owner and the Engineer will witness shop tests of all cone valves.

All testing equipment used will be inspected. The Contractor shall notify the Engineer at least 14 days in advance of the time that the shop test will be conducted. All valves to be tested shall be tested during one trip to the factory of a duration acceptable to the Engineer.

3.2 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.3 SCHEDULE. See Cone Valve Schedule 15106-S01.

End of Section

SECTION 15108

AIR RELEASE AND COMBINATION AIR VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of air release and combination air valves as indicated in the Contract Documents and Air Release and Combination Air Valve Schedule 15108-S01.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable requirements of AWWA C512.

1.2.03 Permanent Number Plates. Each valve shall be provided with a number plate, with at least 1 inch (25 mm) high black baked enamel numerals on anodized aluminum plate. The location of number plates and the method of attachment shall be acceptable to Engineer.

1.3 SUBMITTALS. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS.

Air release valves with operating pressures of 150 psi (1000 kPa) or less shall be Apco/Valve and Primer "No. 200", GA Industries "Figure 920m", Multiplex "Crispin Type N", Val-Matic "No. 38", or approved equal.

Air release valves with operating pressures greater than 150 psi (1000 kPa) shall be Apco/Valve and Primer "No. 200A", GA Industries "Figure 920H", Multiplex "Crispin Type N", Val-Matic "No. 38", or approved equal.

Three inch (75 mm) and smaller combination air valves shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", Val-Matic "Combination Air Valves", or approved equal.

Four inch (100 mm) and larger combination air valves shall consist of an air and vacuum valve with an externally mounted air release valve. The valves shall be Apco/Valve and Primer "Custom Combination Air Valves", GA Industries "Figure 950 Kinetic Custom Combination Air Valves", Multiplex "Crispin Dual Air Valves", Val-Matic "Dual Body Combination Air Valves", or approved equal.

Three inch (75 mm) and smaller air release and vacuum relief valves for vertical diffusion vane pumps shall be of the kinetic energy type with a valve assembly which functions as both an air release and a vacuum relief valve. The exhaust from the valve shall be provided with a throttling device for field adjusting the air flow rate. The valves shall be Apco/Valve and Primer "Series 140DAT Air Valves for Vertical Turbine Pumps", GA Industries "Figure 933 Kinetic Air/Vacuum Valve", Multiplex "Crispin Deep Well Air Valve", or approved equal. The discharge from the valve shall be provided with a threaded NPT connection.

Four inch (100 mm) and larger air release and vacuum relief valves for vertical diffusion vane pumps shall be of the kinetic energy type with a valve assembly which functions as both an air release and a vacuum relief valve. The valve shall be provided with a surge check valve on the valve inlet. The valves shall be Apco/Valve and Primer "Series 1900 Air Valves for Vertical Turbine Pumps", GA Industries "Figure 931 Slow-Closing Kinetic Air/Vacuum Valve", Multiplex "Crispin Air & Vacuum Valve with Surge Check Valve", or approved equal. The discharge from the valve shall be provided with a flanged connection.

2.2 MATERIALS. Except as modified or supplemented herein, materials of construction shall comply with the governing standard. The use of stressed thermoplastic components will not be acceptable.

Valve Trim	Bronze or type 316 stainless steel.

Float	Type 316 stainless steel.
Shop Coatings	
Epoxy (NSF Certified)	Carboline "Carboguard 891" Tnemec "Series N140 Pota-Pox Plus, or approved equal."
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 SHOP COATING. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified inMaster Specification Section 09900, Painting.

Surfaces shall be painted as indicated:

Interior Surfaces	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

Interior epoxy coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.4 SHUTOFF VALVES. A shutoff valve shall be provided in the piping leading to each air release valve and combination air valve. Each 4 inch (100 mm) and larger combination air valve shall be provided with a shutoff valve between the air and vacuum valve and the air release valve.

PART 3 - EXECUTION

3.1 INSTALLATION. Air release and combination air valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.2 SCHEDULE. See Air Release and Combination Air Valve Schedule 15108-S01.

End of Section

SECTION 15130

INDICATING DEVICES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of line-mounted, local indicating devices and accessories.

Remote indicating devices or transmitters are covered in Master Specification Section 17500, Instrumentation General Requirements. Temperature wells (thermowells) are covered in Master Specification Section 15020, Miscellaneous Piping and Accessories Installation. Devices to be furnished by an equipment supplier, either with an item of equipment or as a component of an equipment package, are covered in the applicable equipment section.

Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

1.2.01 Coordination. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all pressure gauges shall conform to the requirements of ANSI/ASME B40.1.

1.2.04 Temporary Number Plates. Each device shall be factory tagged or marked to identify the device by type and number, as indicated.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete drawings or catalog cuts, together with detailed specifications and data covering materials used, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance withMaster Specification Section 01160, Training and Operation & Maintenance Manuals.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with therequirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the specified conditions as indicated in the Contract Documents.

2.2 CONSTRUCTION.

2.2.01 Pressure Indicators. Pressure indicators shall be dial type with rotary geared movement and adjustable pointer.

The dial shall be white background with black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees (3.5 rad) nor more than 270 degrees (4.7 rad) or arc.

Pressure indicators shall be as manufactured by 3D Instruments, or approved equal.

2.2.02 Temperature Indicators.

2.2.02.01 Bi-Metal. Bi-metal temperature indicators shall be hermetically sealed type with external zero adjustment. Indicators shall be furnished with angularly adjustable frame to permit positioning of the dial to accommodate easy viewing.

2.2.02.02 Filled Temperature Indicators. Gas-filled temperature indicators shall be furnished complete with dial indicator, armored capillary tubing and bulb or temperature sensor. Direct mounted indicators shall have an angularly adjustable frame to permit positioning of the dial to accommodate easy viewing.

2.2.03 Sight Flow Indicators. Sight flow indicators shall be provided as indicated in the Contract Documents to provide a visual indication of flow within a pipe. Sight flow indicators shall be of the double window type.

2.2.04 Rotameters. Rotameters (variable area flow meters) shall be provided as indicated in the Contract Documents. Bypass rotameters shall be furnished complete with both a line orifice plate and a range orifice. The range orifice shall be designed to limit flow through the rotameter to within the range of the rotameter.

2.2.05 Orifice Plates and Flanges. Orifice plates shall be ISA standard plates with concentric bore to the nearest 1/8 inch (3 mm) for the flow range specified. Flanges for the orifice plate will be furnished with jackscrews for installing and removing the orifice plate. Tab or coupon shall be provided that indicates the size of the orifice plate.

2.3 ACCESSORIES.

2.3.01 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 INSPECTION. All equipment and accessories shall be inspected for damage and cleanliness before being installed. Any items damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by the Contractor. Such equipment shall be segregated from the undamaged/clean items and shall be inspected and approved by the Owner or his representative before its use.

3.2 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

All indicating devices shall be installed so they can be easily read from floor/platform level and are readily accessible for maintenance and service.

3.2.01 Pressure Indicators. All pressure indicators installed in steam and any other elevated temperature service shall be protected with a thermal isolator (pigtail). Angle style pigtails shall be used for gauges connected to vertical surfaces. Straight-style pigtails shall be used for gauges connected to horizontal surfaces. Pigtails are not to be insulated.

An isolation valve shall be installed at each pipe branch to a pressure indictor except where in-line, flow-through diaphragm seal gauge isolators are utilized. The valve shall be suitable for the line pressure and temperature and shall allow removal of the indicator while the monitored line is in operation.

3.2.02 Temperature Indicators. All temperature indicators shall be installed in temperature wells (thermowells). Filled system indicator dials shall be mounted on a column or floor support approximately 5 feet (1.5 m) above the viewing floor level. Spare capillary shall be neatly coiled and tied.

3.2.03 Sight Flow Indicators. Flapper type sight flow indicators in horizontal piping shall be installed with the flapper hinge at the top of the pipe.

3.2.04 Rotameters. Rotameters shall be installed between 3 and 6 feet (0.9 and 1.8 m) above the viewing floor level. Rotameters shall be installed with flow vertical upwards

Isolation valves shall be installed in the rotameter inlet and outlet piping near the orifice flanges for bypass rotameters. The isolation valves shall allow removal of the rotameter while the monitored line remains in operation. Unions or flanges shall be provided within 2 feet (0.6 m) of the rotameter to facilitate removal.

3.2.05 Orifice Plates and Flanges. Orifice flanges in horizontal piping runs shall be installed so that the orifice taps are located on the vertical centerline at the top of the pipe for gas service and on the horizontal centerline for liquid and steam service.

Orifice plates and flanges shall be installed with the minimum upstream and downstream lengths of unobstructed pipe as indicated on the drawings.

End of Section

SECTION 15140

PIPE SUPPORTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of pipe hangers, brackets, and supports. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories. This section also covers the spacing of expansion joints in piping systems. Expansion joint products and materials are covered in the respective piping sections.

Concrete and fabricated steel supports shall be as indicated in the Contract Documents.

1.2 GENERAL. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint. It shall be Contractor's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to anchor all piping, in accordance with the requirements specified herein. Additional pipe supports may be required adjacent to expansion joints, couplings, or valves.

All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports.

Pipe supports and expansion joints are not required in buried piping, but concrete blocking or other suitable anchorage shall be provided as indicated in theContract Documents.

Piping support system components shall comply with specified piping code requirements.

1.2.01 Abbreviations. Reference to standards and organizations in this section shall be as indicated by the following designations.

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
MSS	Manufacturers Standardization Society of Value and Fitting

Industry

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.3 SUBMITTALS. Complete data and catalog cuts or drawings covering fabricated pipe supports, fabricated inserts, and stainless steel, galvanized, and copper- and plastic-coated pipe supports shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Data shall include a listing of the intended use and general location of each item submitted.

PART 2 - PRODUCTS

2.1 MATERIALS. Unless otherwise indicated, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the structural and miscellaneous metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.

Unless otherwise specified or indicated on the drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.

Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 12 inches (300 mm) in length.

Unless otherwise acceptable to Engineer, the use of supports which rely on stressed thermoplastic components to support the pipe will not be acceptable.

Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Supports for brass or copper pipe or tubing shall be copper plated. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated.

Stainless steel supports shall be furnished, and shall be AISI Type 304 or 316 stainless steel. Stainless steel supports fabricated by welding shall be AISI Type 304L or 316L.

Hot-dip galvanized supports shall be furnished and shall be in accordance with ASTM A153 and A385.

Pipe support types and application shall comply with Table 1.

PART 3 - EXECUTION

3.1 APPLICATION. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Expansion anchors shall be used to fasten supports to existing concrete and masonry.

Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as specified to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as needed to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.

When expansion joints are necessary, pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required where mechanical couplings are permitted as expansion joints. Guides shall be located on both sides of expansion joints, except where anchors are adjacent to the joint. Unless otherwise indicated on the drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for support. Pipe guides shall be provided at locations as recommended by the manufacturer.

Pipe supports for insulated cold piping systems shall be sized for the outside diameter of the insulated pipe, and an insulation protection shield shall be installed between the support and the insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields for piping larger than 2 inches (50 mm) or when needed to prevent crushing of the insulation. Inserts shall be of the same thickness as the adjacent insulation and shall be vapor sealed.

Insulated hot piping systems shall be supported by clevises, clamps, support saddles, or rollers. Pipe clamps shall be attached directly to the pipe. Support saddles and rollers shall be sized for the outside diameter of the insulated pipe, and an insulation protection saddle shall be installed at the support.

When supports for the FRP piping systems are in contact with less than 180 degrees of the pipe surface or when the width of the support is less than one-third the nominal pipe diameter (4 inches (100 mm] minimum), an FRP or steel saddle, shaped to the outside diameter of the pipe, shall be bonded to at least the bottom 120 degrees of the pipe.

3.2 TYPES OF SUPPORTS. The specific products for pipe supports shall be as indicated in Table 1 for the specified type and size of support.

TABLE 1 - TYPES OF SUPPORTS					
Description and Service				Type	
				MSS SP 69 (Note 1)	Other
Hangers					
	2-1/2 inch (63 mm) and smaller pipe				
		For hot and cold insulating piping			
			Clevis	1	B-Line "B3100" or Grinnell "260"
		Other services			
			J-style	5	B-Line "B3690", Grinnell "67", or Unistrut "J Hanger".
			Clevis	1	B-Line "B3104" or Grinnell "65"
	3 Through 10 inch (75 through 250 mm) pipe				
		For hot insulated piping			

TABLE 1 - TYPES OF SUPPORTS		
Description and Service	Type	
	MSS SP 69 (Note 1)	Other
Double bolt	3	B-Line "B3144" or Grinnell "295"
For cold insulated piping		
Clevis	1	B-Line "B3100" or Grinnell "260"
For uninsulated cold piping		
Clamp	4	B-Line "3140" or Grinnell "212"
Clevis	1	B-Line "B3100" or Grinnell "260"
Other services		
Clevis	1	B-Line "B3100" or Grinnell "260" for steel pipe; B-Line "B3102" or Grinnell "590" for cast iron pipe.
12 inch (300 mm) pipe		
Clevis or saddle	1	See drawings.
14 inch (350 mm) and larger pipe		
Saddle	--	See drawings
Concrete Inserts, Steel		

TABLE 1 - TYPES OF SUPPORTS			
Description and Service		Type	
		MSS SP 69 (Note 1)	Other
	12 inch (300 mm) and smaller pipe	18	Channel 12 ga (2.66 mm thick) galv, 1-5/8 by 1-3/8 inches (41.3 by 34.9 mm), min. 8 inches (200 mm) long, anchor lugs on 4 inch (100 mm) centers, at least three lugs, end caps, and filler strip.
	14 inch (350 mm) and larger pipe, fabricated insert, except as noted	--	See drawings.
Beam Clamps, Malleable Iron or Steel, 12 inch (300 mm) and smaller pipe		21	B-Line "3050" and "3055" or Grinnell "133" and "134"
		28, 29	Grinnell "292"
		30	B-Line "3054" or Grinnell "228"
Side Beam Bracket		34	B-Line "B3062" or Grinnell "202"
Wall Supports and Frames, Steel, 12 inch (300 mm) and smaller pipe (Note 2)			
	Brackets	32	B-Line "B3066" or Grinnell "195"
		33	B-Line "B3067" or Grinnell "199"

TABLE 1 - TYPES OF SUPPORTS			
Description and Service		Type	
		MSS SP 69 (Note 1)	Other
	Prefabricated channels	--	12 ga (2.66 mm thick), galv, 1-5/8 inches (41.3 by 41.3 mm), with suitable brackets and pipe clamps.
	Offset pipe clamp, 1-1/2 inch (38) mm and smaller pipe	--	Galv, 1-1/4 by 3/16 inch (32 by 4.7 mm) steel, with 3/8 inch (9.5 mm) bolts
	Offset pipe clamp, 2 to 3-1/2 inch (50 to 88 mm) pipe	--	Galv, 1-1/4 by 1/4 inch (32 by 6 mm) steel, with 3/8 inch (9.5 mm) bolts
Floor Supports, Steel or Cast Iron			
	6 inch (150 mm) and smaller pipe	37 (with base)	B-Line "B3090" or Grinnell "259"
	8 through 24 inch (200 to 600 mm) pipe	38	B-Line "B3093" or Grinnell "264"
Pipe Alignment Guides		--	B-Line "B3281" Through "B3287" or Grinnell "255"
Turnbuckles Steel		13	B- Line "B3202" or Grinnell "230"
Hanger Rods, Carbon Steel, Threaded Both Ends, 3/8 inch (10 mm) minimum size		--	B - Line "B3205" or Grinnell "140"
Weldness Eye Nut, steel		17	B - Line "B3200" or Grinnell "290".

TABLE 1 - TYPES OF SUPPORTS		
Description and Service	Type	
	MSS SP 69 (Note 1)	Other
Insulation Protection Saddle	39	B - Line "B3160 Series" or Grinnell "160 Series"
Insulation Protection Shield	40	B - Line "B3151" or Grinnell "167"

Table 1 Notes:

1. MSS SP-69 supports and hangers are illustrated on Figure 1-15140.
2. Pipe clamps or other devices which rely on the application of a clamping force to the supported pipe in order to maintain the clamp position or location in a prefabricated channel or track will not be acceptable for use with nonmetallic pipe or tubing.

3.3 SUPPORT SPACINGS. Pipe supports and expansion joints shall be spaced in accordance with Tables 2, 3, 4, and 5. The types of pipes to be supported are as indicatbed. Table 2 covers spacings for the standard operating conditions specified for each pipe material. Tables 3 and 4 cover PVC and FRP pipe spacings where operating conditions are in excess of the temperature and specific gravity requirements covered in Table 2. Table 5 covers PVC and FRP pipe which carries air or liquids with a specific gravity other than 1.0.

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
Cast iron		15 (4.5)	80 (24.4)	80 (24.4)	Note 6
Cast iron, glass-lined		12 (3.6)	80 (24.4)	80 [(24.4)	Note 6
Steel, for hot water heating					
	1-1/4 inch (31 mm) and smaller	7 (2.1)	30 (9.1)	100 (30.5)	Note 3
	1-1/2 to 4 inch (38 to 100 mm)	10 (3.0)	30 (9.1)	100 (30.5)	Note 3
	Over 4 inch (100 mm)	15 (4.5)	30 (9.1)	100 (30.5)	Note 3
Steel, for other services					
	1-1/4 inch (31 mm) and smaller	7 (2.1)	30 (9.1)	100 (30.5)	Note 3
	1-1/2 to 4 inch (38 to 100 mm)	10 (3.0)	30 (9.1)	100 (30.5)	Note 3
	Over 4 inch (100 mm)	15 (4.5)	80 (24.4)	80 (24.4)	Note 6
Stainless steel					

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/4 inch (31 mm) and smaller	7 (2.1)	30 (9.1)	100 (30.5)	Note 3
	1-1/2 to 4 inch (38 to 100 mm)	10 (3.0)	30 (9.1)	100 (30.5)	Note 3
	Over 4 inch (100 mm)	15 (4.5)	80 (24.4)	80 (24.5)	Note 3
Copper, for hot water					
	1 inch (25 mm) and smaller	5 (1.5)	20 (6.1)	100 (30.5)	Note 3
	Over 1 inch (25 mm)	7 (2.1)	20 (6.1)	100 (30.5)	Note 3
Copper, for other services					
	1 inch (25 mm) and smaller	5 (1.5)	--	--	Note 7
	Over 1 inch (25 mm)	7 (2.1)	50 (15.2)	100 (30.5)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
PVC, Schedule 80, for alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution at a maximum temperature of 100°F (38°C).					
	1/8 and 1/4 inch (3 and 6 mm)	Continuous Support	20 (6.1)	60 (18.3)	Note 3
	1/2 inch (13 mm)	3-1/2 (1)	20 (6.1)	60 (18.3)	Note 3
	3/4 inch (19 mm)	4 (1.2)	20 (6.1)	60 (18.3)	Note 3
	1 and 1-1/4 inch (25 and 31 mm)	4-1/2 (1.3)	20 (6.1)	60 (18.3)	Note 3
	1-1/2 and 2 inch (38 and 50 mm)	5 (1.5)	20 (6.1)	60 (18.3)	Note 3
	2-1/2 inch (63 mm)	5-1/2 (1.6)	20 (6.1)	60 (18.3)	Note 3
	3 inch (75 mm)	6-1/2 (1.9)	20 (6.1)	60 (18.3)	Note 3
	4 inch (100 mm)	7 (2.1)	20 (6.1)	60 (18.3)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	6 inch (150 mm)	8 (2.4)	20 (6.1)	60 (18.3)	Note 3
	8 inch (200 mm)	9 (2.7)	20 (6.1)	60 (18.3)	Note 3
	10 inch (250 mm)	9-1/2 (2.9)	20 (6.1)	60 (18.3)	Note 3
	12 inch (300 mm)	10 (3.0)	20 (6.1)	60 (18.3)	Note 3
PVC, Schedule 80, for other services at a maximum temperature of 100°F (38°C) and a maximum specific gravity of 1.0.					
	1/8 and 1/4 inch (3 and 6 mm)	Continuous Support	20 (6.1)	60 (18.3)	Note 3
	1/2 inch (13 mm)	4 (1.2)	20 (6.1)	60 (18.3)	Note 3
	3/4 inch (19 mm)	4-1/2 (1.3)	20 (6.1)	60 (18.3)	Note 3
	1 and 1-1/4 inch (25 and 31 mm)	5 (1.5)	20 (6.1)	60 (18.3)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe		Pipe Support Max Spacing feet (m)	Max Run Without Expansion Joint, Loop, or Bend (Note 1) Feet (m)	Expansion Joint Max Spacing (Note 2) feet (m)	Type of Expansion Joints
	1-1/2 and 2 inch (38 and 50 mm)	5-1/2 (1.6)	20 (6.1)	60 (18.3)	Note 3
	2-1/2 inch (63 mm)	6 (1.8)	20 (6.1)	60 (18.3)	Note 3
	3 inch (75 mm)	7 (2.1)	20 (6.1)	60 (18.3)	Note 3
	4 inch (100 mm)	7-1/2 (2.3)	20 (6.1)	60 (18.3)	Note 3
	6 inch (150 mm)	8-1/2 (2.6)	20 (6.1)	60 (18.3)	Note 3
	8 inch (200 mm)	9-1/2 (2.8)	20 (6.1)	60 (18.3)	Note 3
	10 inch (250 mm)	10 (3.0)	20 (6.1)	60 (18.3)	Note 3
	12 inch (300 mm)	11 (3.3)	20 (6.1)	60 (18.3)	Note 3
FRP, for double containment and single wall pressure pipe at a temperature of 150°F (66°C).					
	1 inch (25 mm)	3-1/2 (1)	60 (18.3)	100 (30.5)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/2 inch (38 mm)	4 (1.2)	60 (18.3)	100 (30.5)	Note 3
	2 inch (50 mm)	5 (1.5)	60 (18.3)	100 (30.5)	Note 3
	3 inch (75 mm)	5-1/2 (1.6)	60 (18.3)	100 (30.5)	Note 3
	4 inch (100 mm)	6 (1.8)	40 (12.2)	100 (30.5)	Note 3
	6 inch (150 mm)	7 (2.1)	40 (12.2)	100 (30.5)	Note 3
	8 inch (200 mm)	8 (2.4)	40 (12.2)	100 (30.5)	Note 3
	10 inch (250 mm)	8-1/2 (2.6)	40 (12.2)	100 (30.5)	Note 3
	12 inch (300 mm) and larger	9 (2.7)	40 (12.2)	100 (30.5)	Note 3
FRP, for low pressure and odor control pipe at a maximum temperature of 150°F (66°C) and a maximum specific gravity of 1.0.					
	1 inch (25 mm)	4 (1.2)	60 (18.3)	100 (30.5)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/2 inch (38 mm)	4-1/2 (1.3)	60 (18.3)	100 (30.5)	Note 3
	2 inch (50 mm)	5-1/2 (1.6)	60 (18.3)	100 (30.5)	Note 3
	3 inch (76 mm)	6 (1.8)	60 (18.3)	100 (30.5)	Note 3
	4 inch (100 mm)	6-1/2 (2)	40 (12.2)	100 (30.5)	Note 3
	6 inch (150 mm)	7-1/2 (2.3)	40 (12.2)	100 (30.5)	Note 3
	8 inch (200 mm)	8-1/2 (2.6)	40 (12.2)	100 (30.5)	Note 3
	10 inch (250 mm)	9-1/2 (2.8)	40 (12.2)	100 (30.5)	Note 3
	12 inch (300 mm) and larger	10 (3.0)	40 (12.2)	100 (30.5)	Note 3
Tempered glass (Note 4)		8 (2.4)	--	--	Note 7
High silicon iron (Note 5)		15 (4.5)	--	--	Note 7

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
Polypropylene DWV		6 (1.8)	--	--	Note 7
PVDF DWV		6 (1.8)	--	--	Note 7
Cast iron soil pipe		10 (3.0)	--	--	Notes 7, 8
PVC, Schedule 40, for services at a maximum temperature of 100°F (38°C), and a maximum specific gravity of 1.0.					
	1/8 and 1/4 inch (3 and 6 mm)	Continuous Support	20 (6.1)	60 (18.3)	Note 3
	1/2 inch (13 mm)	3-1/2 (1.0)	20 (6.1)	60 (18.3)	Note 3
	3/4 and 1 inch (19 and 25 mm)	4 (1.2)	20 (6.1)	60 (18.3)	Note 3
	1-1/4 and 1-1/2 inch (31 and 38 mm)	4-1/2 (1.3)	20 (6.1)	60 (18.3)	Note 3
	2 inch (50 mm)	5 (1.5)	20 (6.1)	60 (18.3)	Note 3
	2-1/2 inch (63 mm)	5-1/2 (1.6)	20 (6.1)	60 (18.3)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	3 inch (75 mm)	6 (1.8)	20 (6.1)	60 (18.3)	Note 3
	4 inch (100 mm)	6-1/2 (1.9)	20 (6.1)	60 (18.3)	Note 3
	6 inch (150 mm)	7-1/2 (2.2)	20 (6.1)	60 (18.3)	Note 3
	8 inch (200 mm)	8 (2.4)	20 (6.1)	60 (18.3)	Note 3
	10 inch (250 mm)	8-1/2 (2.5)	20 (6.1)	60 (18.3)	Note 3
	12 inch (300 mm)	9-1/2 (2.9)	20 (6.1)	60 (18.3)	Note 3

Table 2 Notes:

1. Unless otherwise acceptable to Engineer, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.

2. Unless otherwise acceptable to Engineer, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.

3. Expansion joint fittings are specified in the respective piping procurement sections.

4. At least two properly padded supports for each pipe section.

5. At least one support for each pipe section.

6. Expansion joints shall be mechanical couplings.

7. No expansion joints are required.

8. Supports for 5 and 10 foot (1.5 and 3 m) long pipe sections shall be located within 18 inches (460 mm) of each joint. Supports shall be positioned to maintain the piping alignment and to prevent the piping from sagging.

3.3.01 <u>Temperature Adjustments for PVC Pipe</u>. PVC pipe at a temperature above 100°F (38°C) shall have maximum support spacings in accordance with the following table. For insulated lines, reduce the support spacing to 70 percent of the listed values.

TABLE 3 - MAXIMUM PIPE SUPPORT SPACINGS FOR PVC PIPE AT NON-STANDARD TEMPERATURES

feet (meters)

Nominal Size	Schedule 40		Schedule 80	
inches (mm)	120°F (49°C)	140°F (60°C)	120°F (49°C)	140°F (60°C)
1/4 (6)	Continuous Support		Continuous Support	
1/2 (13)	3 (0.9)	2-1/2 (0.7)	3-1/2 (1.0)	3 (0.9)
3/4 (19)	3-1/2 (1.0)	3 (0.9)	4 (1.2)	3 (0.9)
1 (25)	3-1/2 (1.0)	3 (0.9)	4-1/2 (1.3)	3-1/2 (1.0)
1-1/4 (31)	4 (1.2)	3-1/2 (1.0)	4-1/2 (1.3)	4 (1.2)
1-1/2 (38)	4 (1.2)	3-1/2 (1.0)	5 (1.5)	4 (1.2)

TABLE 3 - MAXIMUM PIPE SUPPORT SPACINGS FOR PVC PIPE AT NON-STANDARD TEMPERATURES
feet (meters)

Nominal Size	Schedule 40		Schedule 80	
inches (mm)	120°F (49°C)	140°F (60°C)	120°F (49°C)	140°F (60°C)
2 (50)	4-1/2 (1.3)	3-1/2 (1.0)	5 (1.5)	4-1/2 (1.3)
2-1/2 (63)	4-1/2 (1.3)	4 (1.2)	5-1/2 (1.6)	4-1/2 (1.3)
3 (75)	5 (1.5)	4 (1.2)	6 (1.8)	5 (1.5)
4 (100)	5-1/2 (1.6)	4-1/2 (1.3)	6-1/2 (1.9)	5-1/2 (1.6)
6 (150)	6-1/2 (1.9)	5 (1.5)	8 (2.4)	6-1/2 (1.9)
8 (200)	7 (2.1)	5-1/2 (1.6)	8-1.2 (2.5)	7 (2.1)
10 (250)	7-1/2 (2.2)	6 (1.8)	9 (2.7)	7-1/2 (2.2)
12 (300)	8 (2.4)	6-1/2 (1.9)	10 (3.0)	8-1/2 (2.5)

3.3.02 Temperature Adjustments for FRP Pipe. FRP pipe at a temperature above and below 150°F (66°C) shall have maximum support spacings in accordance with the following table.

TABLE 4 - MAXIMUM PIPE SUPPORT SPACINGS FOR FRP PIPE AT NON-STANDARD TEMPERATURES
feet (meters)

Nominal Size inches (mm)	Temperature		
	75°F (24°C)	175°F (79°C)	200°F (93°C)
1 (25)	5 (1.5)	3 (0.9)	2 (0.6)
1-1/2 (38)	6 (1.8)	3-1/2 (1.0)	2-1/2 (0.7)

TABLE 4 - MAXIMUM PIPE SUPPORT SPACINGS FOR FRP PIPE AT NON-STANDARD TEMPERATURES feet (meters)			
Nominal Size inches (mm)	Temperature		
	75°F (24°C)	175°F (79°C)	200°F (93°C)
2 (50)	7 (2.1)	4 (1.2)	3 (0.9)
3 (75)	7-1/2 (2.2)	4-1/2 (1.3)	3-1/2 (1.0)
4 (100)	8 (2.4)	5 (1.5)	4 (1.2)
6 (150)	10 (3.0)	6 (1.8)	4-1/2 (1.3)
8 (200)	11 (3.3)	6-1/2 (1.9)	5 (1.5)
10 (250)	12-1/2 (3.8)	7-1/2 (2.2)	5-1/2 (1.6)
12 (300)	13 (3.9)	8 (2.4)	6 (1.8)

3.3.03 Specific Gravity Adjustments for PVC and FRP Pipe. PVC and FRP pipe shall have the maximum spacing indicated in Tables 2, 3, and 4 adjusted in accordance with the following table when the specific gravity of the liquid is greater than 1.0. Table 5 shall not apply to PVC pipe containing alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution, as these services are specifically covered in Table 2.

TABLE 5 - MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND FRP PIPE	
Specific Gravity	Correction Factor
1.0	1.00
1.1	0.98
1.2	0.96

TABLE 5 - MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND FRP PIPE

Specific Gravity	Correction Factor
1.4	0.93
1.6	0.90
2.0	0.85
2.5	0.80
Air	1.40

3.4 INSTALLATION.

3.4.01 General. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas.

Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon total weight supported. Spacing of assemblies shall be determined by the minimum pipe size included in the group supported. Trapeze horizontal assemblies shall be structural angle or channel section of sufficient size to prevent measurable sag between rods. All lines shall be attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.

No copper pipe shall contact a pipe support or hanger of dissimilar metal. Hangers and supports for copper pipe shall be copper-plated, plastic coated, or copper pipe shall be galvanically isolated using Neoprene strips or other material as approved.

No piping shall be supported from the pipe above.

Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, or welded beam clips. Hanger support rods shall attach to concrete slabs or beams with inserts.

Anchorage shall be provided to resist both lateral and longitudinal seismic forces. Seismic forces shall be calculated assuming the pipes are full.

3.4.02 Inserts. Reference building structural concrete drawings for concrete inserts. When not provided as part of the building concrete structure, provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

Where concrete slabs form finished ceilings, provide inserts flush with the slab surface.

Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. X-ray locate existing reinforcing rods before drilling.

3.4.03 Pipe Hangers and Supports. Hanger rod sizing for copper pipe and plastic pipe shall be same as for steel pipe. Install hangers to provide a minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

A hanger shall be placed with 18 inches (450 mm) of each horizontal elbow, and on both sides of all piping accessories and valves weighing 20 pounds (9 kg) or more.

Hangers shall have 1-1/2 inches (38 mm) minimum vertical adjustment.

Support horizontal cast iron and no-hub piping systems adjacent to each joint.

Support vertical piping at every floor using riser clamps.

Support riser piping independently or connected horizontal piping.

Hanger and hanger components shall be sized specifically for the pipe size it is to be used on.

3.5 PLACEMENT. Unless closer spacing is indicated on the drawings, the maximum spacing for pipe supports and expansion joints shall be as indicated in Tables 2, 3, 4, and 5.

Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

Unless otherwise indicated on the drawings or acceptable to Engineer, piping shall be supported approximately 1-1/2 inches (38 mm) out from the face of walls and at least 3 inches (75 mm) below ceilings.

End of Section

SECTION 15150

WATER METERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of water meters and associated appurtenances at the locations indicated on the drawings.

Pipe materials, valves, insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other Master Specification sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts. and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Power Supply. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.03 Number Plates. Each water meter which has been assigned a number on the drawings shall be provided with a number plate mounted on or adjacent to the device in a manner acceptable to the Engineer. Nameplates shall have black baked enamel letters at least 3/4 inch (19 mm) high on anodized aluminum plate. .

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication, assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Performance curves indicating flow capacity versus pressure drop.

Accuracy.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Power requirements.

Net weight.

Wiring diagrams.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance withMaster Specification Section 01160, Training, and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Construction. Water meters shall be constructed in accordance with the following standards:

Displacement Water Meters	AWWA C700
Turbine Water Meters	AWWA C701
Compound Water Meters	AWWA C702
Propeller Water Meters	AWWA C704

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts. and Tools .

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Water meters shall be designed and selected to meet the specified conditions as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Water meters shall be designed to meet the performance and design conditions indicated in the Contract Documents, and on the water meter schedule.

Each meter shall measure the actual flow within the accuracy specified over the indicated flow range with a water temperature range of 32°F (0°C) to 120°F (50°C). The accuracy shall be expressed as a percentage of the actual flow and not as a percent of maximum flow.

Meter assemblies shall have performance capabilities of continuous operation up to the rated maximum flows without affecting long-term accuracy or causing any undue component wear. All meter assemblies shall also have a 25 percent flow capacity in excess of the maximum flows as indicated in the Contract Documents for intermittent flow demands.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 DESIGN AND CONSTRUCTION.

2.4.01 Displacement Meters. Displacement meters shall be nutating or oscillating disc type with bronze or synthetic polymer housing as indicated in the schedules, thermoplastic plastic chamber and hard rubber disc. Accuracy shall be ±1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Each meter shall be provided with threaded union type spud end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Displacement type meters shall be Badger Meter Inc., "Recordall Disc Meter", ABB Water Meters, Inc, or approved equal.

2.4.02. Turbine Meters. Turbine meters shall be moving rotor type with bronze, cast iron, or 316 stainless steel housing as indicated in the schedules, thermoplastic rotor, ceramic bearings, stainless steel straightening vanes, Buna N "O" ring, and Nitrile head gasket. Accuracy shall be ±1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Meters in 2 inch and smaller sizes shall be provided with threaded union type spud end connections. Meters in larger than 2 inch sizes shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Turbine type meters shall be Badger Meter Inc., "Recordall Turbo Meter", ABB Water Meters, Inc, or approved equal.

2.4.03 Compound Meters. Compound meters shall incorporate a positive displacement chamber for measuring low flows, a turbine chamber for measuring high flows, and a valve for diverting flow to the respective chamber. Compound meters shall be provided with a single housing or may be provided with independent housings factory piped with a single inlet and outlet connection. Meters shall be provided with bronze housings and piping, thermoplastic rotor, valve casing, and disc chamber, and stainless steel straightening vanes. Accuracy shall be ±1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Meters shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Compound type meters shall be Badger Meter Inc., "Recordall Compound Meter", ABB Water Meters, Inc, or approved equal.

2.4.04 Propeller Meters. Propeller meters shall be rotating propeller type with cast iron housing, copper stabilized polypropylene propeller, graphite/stainless steel propeller bearing, graphite/carbide thrust bearing, and stainless steel straightening vanes. Accuracy shall be ±2 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Meters shall be provided with ANSI Class 125 flanged end connections.

Meter register shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Propeller type meters shall be Badger Meter Inc., "Series MFLT Propeller Meter", Sparling Instruments, Inc, or approved equal.

2.5 PAINTING AND COATINGS.

2.5.01 Surface Preparation. All iron and steel surfaces shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint or coating manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.5.02 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Coatings located in water passages shall comply with AWWA requirements for use with potable water and shall be NSF certified. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Master Specification Section 09900, Painting.

2.6 ELECTRICAL. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Meters shall be installed with the required upstream and downstream straight pipe lengths as recommended by the manufacturer.

3.3 FIELD QUALITY CONTROL.

3.3.01 Installation Check. Unless indicated otherwise, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.4 ADJUSTING. Meters shall be calibrated and adjusted according to manufacturer's written instructions after installation. Meter faces shall be adjusted to proper angle for best visibility.

3.5 PROTECTION. Meters and appurtenances shall be protected from damage immediately after installation. Scratched, cracked or broken components shall be replaced. Meters shall not be used during the construction.

3.6 CLEANING. After completion of testing and immediately before the final inspection, meters shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer.

End of Section

SECTION 15180

VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manual and powered valve and gate actuators and accessories.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valve and gate actuators shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.

1.2.01 General Equipment Requirements. The General Equipment Stipulations Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to the equipment and materials furnished under this section.

1.2.02 Governing Standards. Except as modified or supplemented herein, all powered actuators shall conform to applicable requirements of ANSI/AWWA C540.

Except as modified or supplemented herein for butterfly and eccentric plug valves, all manual and cylinder actuators shall conform to the applicable requirements of ANSI/AWWA C504.

Except as modified or supplemented herein for ball valves, all manual actuators shall conform to the applicable requirements of ANSI/AWWA C507.

Except as modified or supplemented herein, all sluice and slide gate, manual actuators shall conform to the applicable requirements of AWWA C501.

1.2.03 Power Supply. Power supply to electric actuators will be as indicated on the valve or gate schedule.

1.2.04 Marking. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.

1.2.05 Temporary Number Plates. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve or gate by number or service as indicated in the valve or gate schedule.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.

When requested by Engineer, certified copies of physical and chemical test results shall be submitted for the materials of construction for the actuator components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.

Certified copies of reports covering proof-of-design testing of each electrically operated or controlled actuator, as set forth in Section 6 of ANSI/AWWA C540 together with an affidavit of compliance, as indicated in Section 1.7 of ANSI/AWWA C540 shall be submitted to Engineer before the actuators are shipped.

1.4 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

2.1.01 General. Valve and gate actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective Master Specification valve and gate sections.

Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

2.1.02 Valve Actuators. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve and gate section schedules.

Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and handwheel or chainwheel positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the drawings or directed by Engineer.

2.1.03 Gate Actuators. Actuators, regardless of type, shall be sized to produce the torque or thrust required to operate the applicable gate when the gate is subject to the seating and unseating operating heads as indicated in the respective gate section schedules.

Both the design head and the operating head shall be measured from the surface of the liquid to the center line of the gate.

2.1.04 Limit Switches. When manual or cylinder operated valves or gates require limit switches for instrumentation or controls, the limit switches shall be provided as required in their respective valve and gate schedules.

Each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts dc. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".

2.1.05 Sealing. When valves are to be buried, submerged, or installed in vaults, the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective schedules but not less than 20 feet (6.1 m).

2.2 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of ANSI/AWWA C504 and C540.

2.3 VALVE MANUAL ACTUATORS.

2.3.01 General. Manual actuators of the types listed in the Valve Schedules shall be provided by the valve manufacturer.

All valves, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

Unless otherwise required by Owner, the direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open. The direction of rotation of the wheel or wrench nut to open gate valves shall be to the right (clockwise).

The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

Each valve actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator. Other lever actuators shall be designed so that the valve can be readily locked open, closed, or in at least five intermediate positions.

Geared actuators for plug valves not listed in the Eccentric Plug Valve Schedule shall be rated for a differential pressure across the valve, on the seating side of 100 psi (680 kPa) for 8 inch (200 mm) and smaller valves, 50 psi (340 kPa) for 10 inch (250 mm) and larger valves, and 25 psi (170 kPa) for gas service valves.

Manual actuators shall produce the required torque with a maximum pull of 80 pounds (356 N) on the lever or handwheel. Actuator components shall withstand, without damage, a pull of 200 pounds (890 N) on the handwheel or chainwheel or an input of 300 foot-pounds (407 J) on the operating nut.

2.3.02 Handwheels. Handwheel diameters shall be at least 8 inches (150 mm) but not more than 24 inches (600 mm) for 30 inch (750 mm) and smaller valves and not more than 30 inches (750 mm) for 36 inch (900 mm) and larger valves.

2.3.03 Chainwheels. Unless specifically required to be equipped with other types of actuators in the respective valve schedules, all valves with center lines more than 7'-6" (2.3 m) above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet (1.2 m) of the floor below the valve.

2.3.04 Lever Actuators. Lever actuators shall be designed to produce the specified torque with a maximum pull of 80 pounds (350 N). Levers on valves for throttling service shall have an infinitely variable locking device, and levers for other valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.

2.3.05 Chain Levers. Chain lever actuators shall be designed to produce the specified torque with a maximum pull of 80 pounds (350 N) on the chain. Suitable actuator extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet (1200 mm) of the floor below the valve.

2.3.06 Wrench Nuts. Wrench nuts shall be provided on all buried valves, on all valves that are to be operated through floor boxes, and where indicated on the drawings. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 3.16 of AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

2.3.07 Operating Stands. Operating stands shall be provided in the locations indicated on the drawings. Operating stands shall support the handwheel approximately 36 inches (900 mm) above the floor. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet (3 m) or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem. Operating stands in exterior locations shall be cast iron. Operating stands in interior locations shall be cast iron or fabricated steel as indicated in the Contract Documents.

2.3.08 Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the drawings or indicated in the respective gate schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2.4 GATE MANUAL ACTUATORS.

2.4.01 General. Manual actuators of the types as required for each gate in the Gate Schedules shall be provided by the gate manufacturer.

All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings or needle bearings.

All manual actuators shall conform to the requirements of Section 3.14 of AWWA C501, or each manual actuator shall be designed to operate the gate when a 40 pound (178 N) effort is applied to the crank or the handwheel and shall be able to withstand, without damage, an effort of 200 pounds (890 N), as required.

When specified, manual actuators for rising stem self-contained gates shall be designed for mounting directly on the frame yoke.

When a portable electric actuator will be furnished, all crank-operated geared manual actuators shall be suitable for operation with the portable electric actuator specified herein. A suitable adapter coupling shall be furnished with each manual actuator when required to couple the portable actuator to the actuator pinion shaft.

2.4.02 Floorstands. Floorstands shall be designed to transfer operating thrusts to the supporting structure. Each floorstand shall be designed to position the crank or the handwheel approximately 36 inches (900 mm) above the frame yoke, supporting surface, or adjacent operating floor or platform.

2.4.03 Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the drawings or indicated in the respective gate schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2.4.04 Dual Actuators. Dual actuators shall be provided for the gates so indicated in the respective gate schedules. Dual actuators shall be interconnected by a cross shaft complete with required couplings so both stems move at the same rate. Each cross shaft shall be protected by a full length removable aluminum or stainless steel cover attached to the yoke beam or actuator.

2.4.05 Remote Actuators. Gates as indicated in the respective gate schedules, to be provided with a remote actuator, shall be operated by a frame-mounted handwheel and chain drive. An extension shaft suitable for connection to the pinion shaft of the benchstand shall be provided complete with a roller chain, shaft couplings, support bearings, and a roller chain sprocket keyed or bolted to the end of the shaft. A handwheel with bearing housing and sprocket shall be bolted to the side frame approximately 48 inches (1200 mm) above the operating floor. Removable aluminum or stainless steel weathertight covers shall be provided to protect the extension shaft, drive chain, and sprockets. Handwheel and sprocket diameters shall be selected to operate the gate under the maximum specified seating pressure with an effort of not more than 40 pounds (178 N) applied to the rim of the handwheel. Handwheels and sprockets shall be able to withstand a 100 pound (445 N) effort without damage.

2.4.06 Stem Covers. Unless otherwise specified, each rising stem manual actuator shall be provided with a stem cover. Stem covers shall conform to Section 3.4 of AWWA C501.

2.4.06.01 Plastic Covers. When specified in the respective gate schedule, stem covers shall be constructed of transparent plastic pipe and shall be furnished with an end cap, condensation vents, and a clear mylar position-indicating marking tape. The marking tape shall be adhesive backed and shall be permanently marked and calibrated in feet and inches [meters and millimeters]. The tape shall be applied to the stem cover after the gate has been installed and shall be so positioned that the height of the slide will be indicated by reference to the top of the stem.

2.4.06.02 Steel Covers. When specified in the respective gate schedule, stem covers shall be constructed from steel pipe and shall be furnished complete with a threaded end cap. All steel components of each cover shall be hot-dip galvanized following fabrication.

2.4.06.03 Slide Position Indicators. Each sluice gate operating mechanism with a steel stem cover shall be furnished with a digital or dial type mechanical position indicator. The indicator mechanism shall be installed inside a weatherproof housing and shall be clearly visible through a transparent, weatherproof window.

2.5 ELECTRIC ACTUATORS.

2.5.01 General. Electric actuators as listed in the Valve and Gate Schedules shall be provided by the valve or gate manufacturer.

Electric actuators for 12 inch (300 mm) and smaller butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Auma "SG05.1" through "SG12.1", EIM Series HQ, Limitorque "QX", or Rotork "IQT", without exception.

All other electric actuators shall be multiturn type and shall be Auma "SA07.2" through "SA48.1", EIM "Series M2CP", Limitorque "L120" with "B320" bevel gearbox operator, or Rotork "IQ3" with "Type MTW" or "Type IWS" worm gear operator, without exception.

Electric actuators produced by other manufacturers are not acceptable.
Each electric actuator shall be furnished complete with a motor, gearing, handwheel, limit switches and torque sensors, lubricants, heating elements, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a cast

iron, weatherproof, submersible, or explosionproof housing, as specified herein, and shall be integrally assembled on the applicable valve or gate by the valve or gate manufacturer. Housings for quarter-turn actuators may be cast iron or die-cast aluminum alloy.

Actuators for valves and gates shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or as required.

Actuator motors may be mounted horizontally adjacent or vertically above the reduction gearing. All gearing shall be either oil bath or grease lubricated. When grease lubrication is used, in no case shall motors be mounted vertically below the gearing.

2.5.02 Motors. Motors shall be totally enclosed, high torque design made expressly for valve actuator service, capable of operating the valve under full differential pressure for a complete open-close and reverse cycle of travel at least twice in immediate succession without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated.

2.5.03 Power Gearing. Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to at least 350 Brinell. Planetary or cycloidal gearing or aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated. If a secondary gear box is required, it shall be designed to withstand the locked rotor torque of the actuator.

2.5.04 Handwheel Mechanism. The handwheel shall not rotate during motor operation. During handwheel operation the motor shall not affect the actuator operation. The actuator shall be responsive to electrical power and control at all times and, when under electrical control, shall instantly disengage the handwheel. Unless otherwise required by Owner, the handwheel shall rotate counterclockwise to open the valve. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel. The force required to operate the handwheel shall not exceed 80 pounds (350 N).

2.5.05 Torque Sensing. Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Each torque sensing device shall be provided with an adjustment setting indicator. The adjustment shall permit a variation of approximately 40 percent in torque setting. Switches shall have a rating of not less than 6 amperes at 120 volts ac and 0.5 ampere at 115 volts dc.

2.5.06 Limit Switches. Each electric actuator shall be designed to be readily field adaptable for four limit switch assemblies. Each switch assembly shall consist of at least three separate limit switches, shall be operated by the driving mechanism, and shall be independently adjustable to trip at any point at and between the fully open and fully closed valve positions. All switches shall have an inductive contact rating of not less than 6 amperes at 120 volts ac, 3 amperes at 240 volts ac, 1.5 amperes at 480 volts ac, and 0.5 ampere at 115 volts dc.

Each quarter-turn actuator shall be provided with end-of-travel limit switches in addition to four spdt switches, each independently adjustable at any point of valve travel.

2.5.07 Position Transmitter. When specified, valves shall be provided with an electronic type position transmitter. The transmitter output shall be an isolated 4-20 mA dc capable of driving an external load of 0 to 500 ohms. Accuracy of the transmitted signal shall be plus or minus 2.0 percent of span. Repeatability and hysteresis shall be within 1.0 percent. The transmitter shall transmit to a remote position indicator which is specified in the instrumentation section.

2.5.08 Heating Elements. Space heating elements shall be provided to prevent condensation in the motor and limit switch housing. Heating elements shall be rated 120 volts ac. Heaters shall be continuously energized.

2.5.09 Terminal Facilities. Terminal facilities for connection to motor leads, switches, position transmitter, and heating elements shall be provided in readily accessible terminal compartments. Each terminal compartment shall have at least two openings for external electrical conduits, one sized at least 3/4 inch (19 mm) and the other at least 1-1/4 inches (31 mm). Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12 AWG (4 mm^2) conductors.

2.5.10 Controller. Each valve shall be furnished with a reversing controller located either inside the actuator housing or mounted on the housing in a NEMA Type 4 or stainless steel enclosure as required. The controller shall be equipped with:

A motor overload protective device in each phase or solid state motor protection.

A space heater element, rated 120 volts ac, sized to be continuously energized for prevention of condensation within the controller enclosure.

A fused control power circuit taken from one power lead on the load side of the breaker and line side of the reversing starter to ground. If power supply is greater than 120 volts ac, a control power transformer with fused secondary, with volt-ampere capacity suitable for starter control plus continuous service to space heater elements in motor housing, limit switch compartment, and controller enclosure.

A terminal block with connectors for all external controls. All leads from the actuator motor and limit switch assembly shall be routed to terminal connections in the controller for external connections to all other control devices.

Reversing controllers shall be both mechanically and electrically interlocked and provided with the necessary direct-operated auxiliary contacts for required interlocking and control.

Valve controllers shall be expressly selected for long life and reliable, low maintenance service under rugged service conditions.

2.5.11 Control Module. Valves listed for modulating service in the Butterfly Valve Schedule shall be provided with a control module for position modulating type service. The control module shall be mounted within the valve actuator limit switch housing. The module shall accept a standard 4-20 mA dc analog input signal with a load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband.

The actuator shall have a slide-wire type position feedback potentiometer which provides a position feedback signal to the control module.

A "Manual-Automatic" selector switch shall be provided. When specified herein, the actuators shall have "Open-Close" momentary contact push buttons for local electric operation in the manual mode.

2.5.11.01 Control Performance. For any operating torque within the specified range of the valve actuator, the valve and actuator shall perform within these specified limits:

Linearity	Linearity of actual valve position as compared to demand signal shall be within plus or minus 4.0 percent of span over the entire operating range.
Repeatability	For any repeated demand signal to the valve

	actuator, the actual valve position shall be repeated
Deadband	Deadband of the valve actuator shall be adjustable from 1.0 to 10 percent of span.
Hysteresis	For any repeated demand signal to the valve actuator, from either an increasing or a decreasing direction, the actual valve position shall be repeated within 1 degree of valve shaft rotation.

2.6 HYDRAULIC CYLINDER ACTUATORS.

2.6.01 General. Hydraulic cylinder actuators as listed in the Valve or Gate Schedules shall be provided by the valve or gate manufacturer.

2.6.02 Hydraulic Cylinder Actuators. Hydraulic cylinder actuators of the double acting type shall be provided by the valve manufacturer. Cylinders shall be of tie-rod or bolted-flange construction; shall be sized to provide the safety factors stipulated in Table 6 in Section 3.8 of ANSI/AWWA C504; and shall be designed to provide satisfactory operation with either water or oil as required. Operating pressure range shall be as required. Cylinders shall be shop tested at 300 psig [2070 kPa gauge]. Actuators with nonmetallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view.

2.6.03 Control Devices. When specified in the respective valve schedule, a 4-way solenoid valve, with manual actuator when specified herein, shall be provided to control the operation of each hydraulic cylinder operated valve. Each solenoid valve shall be heavy-duty, single solenoid, two-position type rated for a differential operating hydraulic pressure of 125 psig (860 kPa gauge). Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch (12.7 mm) threaded conduit connection. Solenoid valves shall be rated for use with a power supply, as specified herein, and shall be ASCO "Model No. 8344G70MO 4-Way Pilot Operated Solenoid Valves" with manual override features as manufactured by Automatic Switch Co.

Each hydraulic connection on each cylinder shall be equipped with an adjustable flow control valve. The flow control valves and connecting piping shall be arranged to permit control of the flow rate of exhaust fluid from the cylinder and to permit the independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the cylinder piston to complete its stroke can be adjusted from 30 to 120 seconds with fluid supply pressure as specified herein. Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol".

An oil reservoir shall be provided in the oil piping connecting the two flow control valves on each oil hydraulic cylinder.

2.7 AIR CYLINDER ACTUATORS.

2.7.01 General. Air cylinder actuators as listed in the Valve or Gate Schedules shall be provided by the valve or gate manufacturer.

2.7.02 Air Cylinder Actuators. Air cylinder actuators of the double acting type shall be provided by the valve manufacturer. Cylinders shall be sized to provide the safety factors stipulated in Table 6 in Section 3.8 of ANSI/AWWA C504, except as specified herein, and shall be designed to provide satisfactory operation using air, or when specified herein, dry, oil-free instrument air at 80 psig (550 kPa gauge) pressure and shall be shop tested at 240 psig (1650 kPa gauge).

Actuators with nonmetallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view.

2.7.03 Control Devices. When specified in the respective valve schedule, a 4-way solenoid valve with manual actuator, when required, shall be provided to control the operation of each air cylinder operated valve. Each solenoid valve shall be heavy-duty, single solenoid, two-position type rated for a differential operating air pressure of 125 psig (860 kPa gauge). Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch (12.7 mm) threaded conduit connection. Solenoid valves shall be rated for use with a power supply, as required, and shall be ASCO "Model No. 8344G70MO 4-Way Pilot Operated Solenoid Valves" with manual override features as manufactured by Automatic Switch Co.

Each air connection on each cylinder shall be equipped with an adjustable flow control valve. The flow control valves and connecting piping shall be arranged to permit control of the flow rate of exhaust air from the cylinder and to permit independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the air cylinder piston to complete its stroke is adjustable between 20 and 60 seconds, with an air supply pressure of 80 psig (550 kPa gauge). Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol".

2.7.04 Single Acting-Spring Return Air Cylinder Actuators. When specified in the respective valve schedules, air cylinder actuators of the single acting-spring return type shall be provided by the valve manufacturer. Cylinders shall provide satisfactory operation for air of the specified quality and shall be shop tested at 240 psig (1650 kPa gauge). Actuators with non-metallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view. The actuator shall be configured such that on power failure, the spring shall drive the valve open or closed. Each actuator shall be furnished with a 3-way solenoid valve. A flow control valve shall be furnished and installed in the solenoid valve vent.

2.8 AIR-OIL CYLINDER ACTUATORS.

2.8.01 General. Air-oil cylinder actuators as listed in the Valve or Gate Schedules shall be provided by the valve or gate manufacturer.

2.8.02 Air-Oil Cylinder Actuators. Air-oil cylinder actuators may be of the double acting or opposed cylinder type.

For eccentric plug valves, cylinders shall be of tie-rod or bolted-flange construction and shall be sized to provide the safety factors stipulated in Table 6 in Section 3.8 of ANSI/AWWA C504.

Each cylinder unit shall consist of an air cylinder driving an oil hydraulic cylinder of the same diameter, mounted together as a single assembly. Cylinders shall be of the tie-rod or bolted-flange construction. The air cylinder shall operate the valve, and the oil cylinder shall regulate the opening and closing speeds. Each unit shall be provided with an oil reservoir and two flow control valves on the oil cylinder.

The valve actuator mechanism coupled to the cylinders shall be totally enclosed. The cylinders shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rods shall be enclosed in the mechanism housing and shall not be exposed to view.

The air cylinder shall be designed to provide satisfactory operation using air, or when specified herein, dry, oil-free instrument air at 80 psig (550 kPa gauge) pressure. The oil cylinder shall be designed to operate at an internal pressure not to exceed 80 psig (550 kPa gauge).

For AWWA butterfly valves; actuators with nonmetallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

2.8.03 Control Devices. When specified in the respective valve schedule, a 4-way solenoid valve shall be provided to control the operation of each air-oil cylinder operated valve. Each solenoid valve shall be heavy-duty, single solenoid, two-position type rated for a differential operating air pressure of 125 psig (860 kPa gauge). Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch (12.7 mm) threaded conduit connection. Solenoid valves shall be ASCO "Model No. 8344G70MO 4-Way Pilot Operated Solenoid Valves" with manual override features as manufactured by Automatic Switch Co.

Each oil connection on the oil cylinder shall be equipped with an adjustable flow control valve. The flow control valves and connecting oil piping shall be arranged to permit control of the flow rate of exhaust oil from the cylinder and to permit independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the air cylinder piston to complete its stroke is adjustable between 30 and 300 seconds. Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol". An oil reservoir shall be provided in the oil piping connecting the two flow control valves.

2.9 PORTABLE ELECTRIC ACTUATOR. Contractor shall furnish the number of portable, electric motor driven actuators, as specified herein, with adjustable fabricated steel tripod suitable for operation of all crank-operated gates specified in Master Specification Section 02546, Sluice Gates. When indicated in the Contract Documents the portable electric actuators shall be suitable for operating all existing manual sluice and slide gate actuators.

When indicated in the Contract Documents, the actuator shall be reversible and shall be equipped with an overload release clutch for protection of the operated equipment. The clutch shall be adjustable, spring-loaded, drive-pawl type which releases instantly at a preset, predetermined torque. Disc friction clutches or shear pins will not be acceptable.

The actuator shall be suitable for operation with 120 volt, 60 Hz, single phase power, or as specified herein. A three-conductor, heavy-duty, neoprene jacketed, portable cord, with 12 AWG (4 mm^2) copper conductors and a standard grounding type plug, of a length as specified herein, shall be provided with the actuator.

Coordination of the portable actuator with the all new and existing manual actuators shall be the responsibility of Contractor.

2.10 PORTABLE HYDRAULIC ACTUATOR. Contractor shall furnish the number of portable, hydraulic driven actuators, as indicated in the Contract Documents, suitable for operation of all crank-operated sluice gates specified in Master Specification Section02546, Sluice Gates. When indicated in the Contract Documents the portable hydraulic actuators shall be suitable for operating all existing manual sluice gate actuators.

When indicated in the Contract Documents, the actuator shall be reversible and shall be equipped with an overload release clutch for protection of the operated equipment. The clutch shall be adjustable, spring-loaded, drive-pawl type which releases instantly at a preset, predetermined torque. Disc friction clutches or shear pins will not be acceptable.

The portable hydraulic actuator shall be mounted on a lightweight structural steel frame with two wheels for ease of movement. The unit shall consist of a four-cycle gasoline engine with a recoil starter driving a hydraulic pump. The unit shall include all necessary hoses, a hydraulic motor, oil reservoir and four way valve.

2.11 ACTUATOR ACCESSORIES.

2.11.01 EXTENSION STEMS. Extension stems and stem guides shall be furnished when indicated on the respective valve schedule, indicated on the drawings, or otherwise required for proper valve or gate operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the valve actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.

At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet (3 m), whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

Extension stems for buried valves actuators shall extend to within 6 inches (150 mm) of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.

When indicated in the Contract Documents, extension stems for buried valve actuators shall be provided with position indicators.

2.11.02 POSITION INDICATORS. Unless otherwise specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.

For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.

Each actuator for butterfly valves, except actuators that are located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.

2.11.02.01 Position Indicators for Buried Actuators. When specified in the respective valve schedule, each buried valve actuator shall be equipped with a position indicator. Position indicators shall be Indico "Model 179 Valve Position Indicators" manufactured by the Mills Engineering Company, Needham Heights, Massachusetts, or "Diviner" ground level position indicator manufactured by the Henry Pratt Company, Aurora, Illinois. Each indicator assembly shall be designed for installation on the extension stem connected to the operating stem of the buried actuator mechanism and shall be mounted in the top section of the valve box beneath the valve box cover. Each indicator shall be equipped with a wrench nut. Internal gearing shall be sealed and protected from the elements.

2.11.03 FLOOR BOXES. Openings through concrete slabs provided for key operation of valves shall be provided with a cast iron floor box complete with cover. The floor box shall be of the depth indicated on the drawings. Where the operating nut is in the slab, the stem shall have a guide to maintain the nut in the center of the box; where the nut is below the slab, the opening in the bottom of the box shall accommodate the operating key.

Each floor box and cover shall be shop coated with manufacturer's standard coating.

2.11.04 TORQUE TUBES. Torque tube shall utilize pipe rather than solid shafting between the valve input shaft and the output shaft of the valve floorstand operator. An adjustment of 2 inches shall be provided in the torque tub installation. Torque tube shall be coated with the same material as the submerged valve.

2.12 SHOP COATING. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting in Master Specification Section 09900, Painting.

The following surfaces shall be painted:

Polished or Machined Surfaces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION. Actuators will be installed on the valves in accordance with Master Specification Section 15010, Valve Installation and Master Specification Section 02546, Sluice Gates.

End of Section

SECTION 15190

NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SCOPE. This Section includes fuel gas piping within the building. Products include the following:

Pipe, tube, fittings, and joining materials.

Protective pipe and fitting coating.

Piping specialties

1.2 PROJECT CONDITIONS.

Gas System Pressure: One pressure range. More than 0.5 psig (3.45 kPa) but not more than 5.0 psig (34.5 kPa).

1.3 SUBMITTALS

1.3.01 Product Data. Submit product data for each type of product indicated.

1.3.02 Shop Drawings. Submit shop drawings for fuel gas piping. Include plans and attachments to other work. Show different pressure zones and indicate pressure for each zone.

1.3.03 Field Quality-Control Test Reports. Submit field quality control test report results.

1.3.04 Operation And Maintenance Data. Submit operation and maintenance data for each type of product indicated.

1.4 QUALITY ASSURANCE.

Electrical Components, Devices, and Accessories. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

NFPA Standard. Comply with NFPA 54, "National Fuel Gas Code."

1.5 WARRANTY. In the event that the equipment or components fail to perform satisfactorily at any time within the Defects Liability period the Contractor shall replace it with one capable of operating as specified and shall comply with the requirements in Division 1.

The Contractor shall be responsible for all cost incurred in furnishing and installing the replacement equipment.

1.6 SPARE PARTS. Spare parts shall meet the requirements of Sections 01750 and 01760.

PART 2 - PRODUCTS

2.1 MANUFACTURERS. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

Corrugated, Stainless-Steel Tubing Systems. Comply with AGA LC 1 and include the following:

Tubing: Corrugated stainless steel with plastic jacket or coating.

Fittings: Copper alloy with ends made to fit corrugated tubing. Include ends with threads according to ASME B1.20.1 if connection to threaded pipe or fittings is required.

Striker Plates: Steel, designed to protect tubing from penetrations.

Steel Pipe. ASTM A 53/A 53M; Type E or S; Grade B; Schedule 80; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.

Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.

Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1 or butt-welded joints.

Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.

Joint Compound and Tape: Suitable for natural gas.

Soft Copper Tube. ASTM B 88, Type L (ASTM B 88M, Type B), annealed temper.

Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.

Brazing Filler Metals: AWS A5.8, Silver Classification BAg-1. Filler metal containing phosphorus is prohibited.

2.3 PROTECTIVE COATING. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in contact with materials that may corrode the pipe.

2.4 PIPING SPECIALTIES.

Flexible Connectors. ANSI Z21.24, copper alloy.

Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

PART 3 - EXECUTION

3.1 PREPARATION. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.2 PIPING APPLICATIONS. Use flanges, unions, transition, and special fittings in applications below, unless otherwise indicated.

Fuel Gas Piping, 5 psig (34.5 kPa) or less:

NPS 1/2 (DN 15) and Smaller: NPS 3/4 (DN 20) steel pipe, malleable-iron threaded fittings, and threaded joints, Soft copper tube, copper fittings, and brazed joints and Corrugated, stainless-steel tubing system and threaded joints.

NPS 3/4 and NPS 1 (DN 20 and DN 25): Steel pipe, malleable-iron threaded fittings, and threaded joints, Soft copper tube, copper fittings, and brazed joints, Corrugated, stainless-steel tubing system and threaded joints.

NPS 1-1/4 to NPS 3 (DN 32 to DN 70): Steel pipe, malleable-iron threaded fittings, and threaded joints.

NPS 4 and larger. (DN 100) Steel, malleable-iron threaded fittings and butt-welded joints.

3.3 VALVE APPLICATIONS.

Appliance Shutoff Valves for Pressure 0.5 psig (3.45 kPa) or Less: Appliance connector valve or gas stop.

Appliance Shutoff Valves for Pressure 0.5 to 2 psig (3.45 to 13.8 kPa): Gas stop or gas valve.

Piping Line Valves, NPS 2 (DN 50) and Smaller: Gas valve.

Valves at Service Meter, NPS 2 (DN 50) and Smaller: Gas valve.

3.4 INSTALLATION. Basic piping installation requirements and piping joint construction are specified in Division 15 Section 15051 "Piping- General Requirements."

Install pressure gage, upstream and downstream from each service pressure regulator. Pressure gages are specified in Division 15 Section "Piping Specialties."

Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

Above-Ceiling Locations: Gas piping without conduit may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.

In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.

Underground Locations: Locate buried pipe a maximum depth as required by code to prevent damage. Low points and drip trap legs to be located inside of building.

Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches (75 mm) long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings unless specifically shown to be exposed to view.

Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Connect branch piping from top or side of horizontal piping.

Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

Install pressure gage, upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 15 Section 15120 "Piping Specialties."

Install flanges on valves, specialties, and equipment having NPS 2-1/2 (DN 65) and larger connections.

Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.5 HANGER AND SUPPORT INSTALLATION. Pipe hanger and support devices are specified in Section 15140 - "Pipe Hangers and Supports."

Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).

NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

NPS 2-1/2 and NPS 4 (DN 80 and DN 100): Maximum span

Install hangers for horizontal corrugated, stainless-steel tubing with the following maximum spacing and minimum rod sizes:

NPS 3/8 and NPS 1/2 (DN 10 and DN 15): Maximum span, 48 inches (1219 mm); minimum rod size, 3/8 inch (10 mm).

NPS 3/4 and NPS 1 (DN 20 and DN 25): Maximum span, 72 inches (1829 mm); minimum rod size, 3/8 inch (10 mm).

Option: Support tubing from structure according to manufacturer's written instructions.

3.6 CONNECTIONS. Install piping adjacent to appliances to allow service and maintenance. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches (1800 mm) of each appliance. Install union downstream from valve.

3.7 FIELD QUALITY CONTROL. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

End of Section

SECTION 15200

STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 SCOPE. this Section covers the installation of Low Pressure steam (less than 15 psig) and condensate steel piping together with fittings, specials and appurtenances for the services as indicated in the contract documents. Pipe and tubing shall be furnished complete with all fittings, flanges, unions and other accessories specified herein.

Pipe supports, anchors and expansion joints shall be furnished by Contractor, and are covered in Master Specifications Section 15140, Pipe Supports.

1.2 PERFORMANCE REQUIREMENTS. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

LP Steam Piping: 15 psig

Condensate Piping: Gravity at 250 deg F.

Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.3 SUBMITTALS.

1.3.01 Product Data. For each type of the following:

Pressure-reducing and safety valves.

Steam traps.

Thermostatic air vents and vacuum breakers.

Steam and Condensate piping.

Strainers, fittings, and valves.

1.3.02 Shop Drawings. Submittal of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

1.3.03 Reports. Field quality-control test reports.

1.3.04 O & M. Operation and maintenance data.

1.4 QUALITY ASSURANCE.

1.4.01 ASME Compliance. Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS.

2.1.01 Steel Pipe. ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

2.1.02 Cast-Iron Threaded Fittings. ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

2.1.03 Malleable-Iron Threaded Fittings. ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

2.1.04 Malleable-Iron Unions. ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

2.1.05 Cast-Iron Threaded Flanges and Flanged Fittings. ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

2.1.06 Stainless-Steel Bellows, Flexible Connectors.

Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.

End Connections: Threaded or flanged to match equipment connected.

Performance: Capable of 3/4-inch misalignment.

CWP Rating: 150 psig.

Maximum Operating Temperature: 250 deg F.

2.2 JOINING MATERIALS.

2.2.01 Pipe-Flange Gasket Materials. Suitable for chemical and thermal conditions of piping system contents.

ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2.2.02 Flange Bolts and Nuts. ASME B18.2.1, carbon steel, unless otherwise indicated.

2.2.03 Solder Filler Metals. ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.2.04 Brazing Filler Metals. AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.3 DIELECTRIC FITTINGS.

2.3.01 Description. Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

2.3.02 Insulating Material. Suitable for system fluid, pressure, and temperature.

2.3.03 Dielectric Unions.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Capitol Manufacturing Company.
Central Plastics Company.
Hart Industries, International Inc.
Watts Water Technologies, Inc.
Zurn Plumbing Products Group.
Or acceptable equal.

Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2.4 VALVES.

2.1.01 Gate, Globe, Check, Ball, and Butterfly Valves. Comply with requirements specified in Division 15, Valve Sections 15091, 15092, 15093 & 15096.

2.5 STRAINERS.

2.5.01 Y-Pattern Strainers.

Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.

End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.

Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.

Tapped blow-off plug.

CWP Rating: 250-psig working steam pressure.

2.6 SAFETY VALVES.

2.6.01 Bronze or Brass Safety Valves.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Armstrong International, Inc.
Kunkle Valve; a Tyco International Ltd. Company.
Spirax Sarco, Inc.
Watts Water Technologies, Inc.
Or acceptable equal.

Disc Material: Forged copper alloy.

End Connections: Threaded inlet and outlet.

Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

Pressure Class: 250.

Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6.02 Cast-Iron Safety Valves.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Armstrong International, Inc.
Kunkle Valve; a Tyco International Ltd. Company.
Spirax Sarco, Inc.
Watts Water Technologies, Inc.
Or acceptable equal.

Disc Material: Forged copper alloy with bronze nozzle.

End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.

Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

Pressure Class: 250.

Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.7 PRESSURE-REDUCING VALVES.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Armstrong International, Inc.
Hoffman Specialty; Division of ITT Industries.
Leslie Controls, Inc.
Spence Engineering Company, Inc.
Spirax Sarco, Inc.
Or acceptable equal.

Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

Body: Cast iron.

End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

Trim: Hardened stainless steel.

Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

Gaskets: Non-asbestos materials.

2.8 STEAM TRAPS.

2.8.01 Inverted Bucket Traps.

Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong TVS-2011S, stainless steel inverted bucket trap with integral isolation valves, strainer and test valve, or a comparable product by one of the following:

Armstrong International, Inc.
Barnes & Jones, Inc.
Dunham-Bush, Inc.
Hoffman Specialty; Division of ITT Industries.
Spirax Sarco Inc.
Or approved equal

Body and Cap: Stainless steel ASTM A240 Grade 304L.

Connection size: 3/4” NPT

Orifice size: 5/32” NPT

End Connections: Threaded.

Head and Seat: Stainless steel.

Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.

Bucket: Stainless steel.

Strainer: Integral stainless-steel inlet strainer within the trap body.

Air Vent: Stainless-steel thermostatic vent.

Pressure Rating: 400 psig.

2.9 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS.

2.9.01 Thermostatic Air Vent/Vacuum Breaker.

Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong TVAB-3, stainless steel combination Thermostatic Air Vent/Vacuum Breaker, or a comparable product by one of the following:

Armstrong International, Inc.
Barnes & Jones, Inc.
Dunham-Bush, Inc.
Hoffman Specialty; Division of ITT Industries.
Spirax Sarco, Inc.
Or acceptable equal.

Body: 304-L Stainless steel

End Connections: Threaded 304 stainless steel

Thermostatic Air Vent: 3/4” NPT

Vacuum Breaker: 3/8” NPT

Valve: Stainless steel

Spring: T302 stainless steel

“O” Ring: EPDM
Screen: Stainless steel

Thermostatic Element: Phosphor-bronze bellows in a stainless-steel cage

Vacuum Breaker Body: T303 stainless steel

Maximum Allowable Pressure: 300 psig @ 365°F

Maximum Operating Pressure: 150 psig

Discharge Orifice Size: 3/16”

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS.

3.1.01 Low Pressure Steam Piping. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.1.02 Condensate Piping above Grade. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.1.03 Condensate Piping below Grade. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.2 ANCILLARY PIPING APPLICATIONS

3.2.01 Air-Vent Piping.

Inlet: Same as service where installed.

Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

3.2.02 Vacuum-Breaker Piping: Outlet, same as service where installed.

3.2.03 Safety-Valve-Inlet and -Outlet Piping. Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 VALVE APPLICATIONS. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.4 PIPING INSTALLATION. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

Install piping to permit valve servicing.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections.

Install piping to allow application of insulation.

Select system components with pressure rating equal to or greater than system operating pressure.

Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

Reduce pipe sizes using eccentric reducer fitting installed with level side down.

Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.

Install valves according to Division 15 Section "Valves."

Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections

of equipment, and elsewhere as indicated.
Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blow-down connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 15, “Sections 15065 & 15140."

Identify piping as specified in Division 15, Section 15200 – Mechanical Identification.

Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

On straight runs with no natural drainage points, install drip legs at intervals not exceeding 500 feet, if possible.

Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

3.5 STEAM-TRAP INSTALLATION. Install steam traps in accessible locations as close as possible to connected equipment.

Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.6 PRESSURE-REDUCING VALVE INSTALLATION. Install pressure-reducing valves in accessible location for maintenance and inspection.

Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

Install gate valves on both sides of pressure-reducing valves.

Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 15, “Section 15130."

Install strainers upstream for pressure-reducing valve.

Install safety valve downstream from pressure-reducing valve station.

3.7 SAFETY VALVE INSTALLATION. Install safety valves according to ASME B31.9, "Building Services Piping."

Pipe safety-valve discharge without valves to atmosphere outside the building. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.8 HANGERS AND SUPPORTS. Install hangers and supports according to Division 15 “Section 15140 - Pipe Supports. Comply with requirements below for maximum spacing.

3.9 PIPE JOINT CONSTRUCTION. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube," using copper-phosphorus brazing filler metal complying with AWS A5.8.

Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

> Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
>
> Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.10 TERMINAL EQUIPMENT CONNECTIONS. Size for supply and return piping connections shall be the same as or larger than equipment connections.

Install traps and control valves in accessible locations close to connected equipment.

Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

Install vacuum breakers downstream from control valve, close to coil inlet connection.

Install a drip leg at coil outlet.

3.11 FIELD QUALITY CONTROL. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

> Leave joints, including welds, un-insulated and exposed for examination during test.
>
> Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
>
> Flush system with clean water. Clean strainers.
>
> Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

Perform the following tests on steam and condensate piping:

> Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
>
> Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
>
> After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test

until there are no leaks.

Prepare written report of testing.

End of Section

SECTION 15245

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of vibration isolation requirements associated with mechanical equipment. Schedules and notes on drawings indicate specific types of isolators required for each equipment.

1.2 GENERAL.

1.2.01 Governing Standards.

ASHRAE (HVACA) – ASHRAE Handbook – HVAC Applications

ASHRAE Refrigeration Handbook

ASTM A 36/A 36 M – Standard Specification for Carbon Structural Steel

1.3 SUBMITTALS.

1.3.01 Shop Drawings. Submit shop drawings for each type of vibration isolator for Engineer's review.

1.3.02 Product Data. Submit product data for vibration isolators indicating the following:

Equipment requiring isolation.

Spring outside diameters.

Free, operating, and solid heights.

1.4 QUALITY ASSURANCE. Isolation materials manufacturer shall be responsible for proper selection of spring rates to accomplish scheduled minimum static deflections, for all spring and pad type isolators, based on weight distribution of equipment requiring isolation.

Refer to Equipment Schedules.

Isolation materials manufacturer shall be responsible for structural design of steel beam bases and concrete inertia bases to support mechanical equipment scheduled to receive supplementary base.

Complete set of reviewed shop drawings of all mechanical equipment to receive vibration isolation devices shall be furnished to vibration isolation materials manufacturer, upon which selection of vibration isolators and design of supplementary bases will be completed.

1.5 WARRANTY. Manufacturer's standard warranty unless noted otherwise.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS.

2.1.01 Selection Criteria. Select vibration isolators for actual load imposed, and in accordance with Table, Selection Guide for Vibration Isolation, in the Sound and Vibration Control chapter of the ASHRAE HVACA.

Scheduled or specified static deflection requirements relate to actual static deflection of individual mounts under their particular loads.

Unacceptable vibration isolator mounts include:

> Vibration isolator mounts selected on the basis of cataloged, nominal static, deflection, while ignoring decrease in isolation efficiency due to loadings to less than those of nominal rating.
>
> Isolator mounts loaded in excess of their rated load capacity.
>
> Isolators selected by equally dividing total weight of equipment by proposed number of isolators. Except where supported equipment is symmetrical about its vertical axis.

Isolator springs shall have ratio of horizontal to vertical spring constants of not less than 0.8, be horizontally unrestrained, of diameter not less than 80 percent of height at rated load and allow reserve travel of 50 percent of rated deflection from height at rated load to shorted turns condition.

Elastic limit of springs shall not be exceeded at shorted turns conditions.

Equip isolator mounts having steel springs with means for leveling suspended equipment.

2.1.02 Floor Mounts. Equip with leveling bolts and locknuts.

Select for convenient bolting of base plates to building structure.

2.1.03 Hanger Mounts. Furnish positioning type hanger isolators that allow installation of equipment and piping at a fixed elevation independent of load changes and subsequent transfer of suspension load to springs.

Option, preloaded hanger isolators may be furnished with preloading devices being backed off after installation.

2.1.04 Coating. Dip coat steel elements of outdoor isolators with weather resistant paint.

2.1.05 Equipment Bases and Rails.

Type A, Concrete Inertia Block Mount.

Concrete inertia block base with steel springs mounted in series with ribbed neoprene pads.

Form concrete sub-bases from prefabricated steel pouring form frames with 1 inch by 1 inch by 1/8 inch angle stiffeners crossed in both directions on 9 inch centers and welded to sides of steel frames, templates to fit equipment anchor bolts, outboard height saver brackets, and spring isolators.

Depth of steel frame shall be not less than 1/12 of its longest span, but not less than 8 inches.

Concrete: 4000 psi, reinforcing steel #4 bars, 12 inches on center each way.

Acceptable Manufacturers:

Korfund Dynamics, Type RCPF with WS mounts.

Mason Industries, Type KSL with SLFH mounts.

Kinetics, Model CIB-H with FDS bolt down mounts.

Vibration Eliminator, Type SN with OST or OSK mounts.

Vibration Mountings and Controls, Type SPF with AEH mounts.

Type B, Structural Steel Base Mounting.

Structural steel base with steel springs mounted in series with elastomer pads or mounts.

Acceptable Manufacturers:

Korfund Dynamics, Spring-Isolated Structural Base with Type WS mounts.

Mason Industries, Type MSL with Type SLFH mounts.

Kinetics, Model SFB with FDS bolt down mounts.

Vibration Eliminator, Type OSK with OST or OSK mounts.

Vibration Mountings and Controls, Type WFB with Type AWH mounts.

<u>Type C, Structural Steel Base Mount</u>.

Structural steel base with double deflection neoprene-in-shear mounts.

Acceptable Manufacturers:

Korfund Dynamics, Structural Base with Type F or H mounts.

Mason Industries, Type MND with ND mounts.

Kinetics, Model SFB with Model RD mounts.

Vibration Eliminator, Type C or D.

Vibration Mountings and Controls, Type WFB with Type RD mounts.

2.1.06 <u>Vibration Isolator Mountings</u>.

<u>Type D, Spring Floor Mount</u>.

Individual steel spring mounts supported on elastomer pads.

Acceptable Manufacturers:

Korfund Dynamics, Type WS Bolt Down Design.

Mason Industries, Type SLFH.

Kinetics, Model FDS Bolt Down Mounts.

Vibration Eliminator, Type OST.

Vibration Mountings and Controls, Type AWH.

Type E, Double Spring Floor Mounts with Lift Restraint.

Double, side-by-side spring mounts with lift restraints, and supported on elastomer pads.

Acceptable Manufacturers:

Korfund Dynamics, Type WSCL.

Mason Industries, Type SLR.

Kinetics, Model FLS.

Vibration Eliminator, Type KW.

Vibration Mountings and Controls, Type AWR.

Type F, Neoprene-In-Shear Floor Mount.

Individual double deflection neoprene-in-shear mounts.

Acceptable Manufacturers:

Korfund Dynamics, Type F.

Mason Industries, Type ND.

Kinetics, Model RD.

Vibration Eliminator, No. 140 or No. 240.

Vibration Mountings and Controls, Type RD.

Type G, Neoprene Pad Floor Mount.

Ribbed or waffle pattern neoprene pads, single or multilayered as required for equipment's static deflection.

Acceptable Manufacturers:

Korfund Dynamics, Korpad.

Mason Industries, Type WSW or Super W.

Kinetics,Model NP or NG.

Vibration Eliminator, Type 100N.

Vibration Mountings and Controls, Shear-Flex.

Type H, Combination Spring and Neoprene-In-Shear Hanger Mount.

Hanger isolators with steel springs mounted in series with elastomer elements.

Acceptable Manufacturers:

Korfund Dynamics, Type VSPL.

Mason Industries, Type PC30N.

Kinetics,Model SRHPL.

Vibration Eliminator, Type PCSR.

Vibration Mountings and Controls, Series RSHP.

Type J, Neoprene-in-Shear Hanger Mount.

Hanger isolators with elastomer elements.

Acceptable Manufacturers:

Korfund Dynamics, Type H.

Mason Industries, Type HD.

Kinetics, Model RH.

Vibration Eliminator, C Series.

Vibration Mountings and Controls, Series RHDC.

Type K, Thrust Restraint.

Thrust restraint, having spring with elastomer element mounted in series, housing, rods, brackets, and means for presetting thrust force.

Acceptable Manufacturers:

Korfund Dynamics, Thrust Restraints.

Mason Industries, Type WB.

Kinetics, Thrust Restrainer.

Vibration Eliminator, Thrust Restraints.

Vibration Mountings and Controls, SH-27.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.1 General. Install vibration isolation materials and equipment bases in accordance with manufacturer's written instructions.

Remove debris trapped between equipment bases and floor.

Level mountings so each mount carries assigned load.

Mounts showing evidence of insufficient or excessive loading, buckling, squirming, totally collapsed springs, making permanent contact with _lift or sag restraints, or shorted springs and elastomer elements will not be accepted.

Install hanger type isolators so no shorting will occur via contact between upper and lower hanger rods or via contact between lower hanger rods and isolator boxes.

Locate floor vibration isolator mounts so base plates are supported in horizontal position by floor slabs, beams, or other structural elements.

Isolator placements resulting in overhanging or tilted base plates or in bending stresses in steel plate or bar grate flooring are unacceptable.

Bolt base plates to supporting structure.

Prepare pouring forms of inertia bases for concrete placement in accordance with manufacturer's instructions.

Make provisions for bond breaking between concrete fill and floor structure.

Vibrate concrete in place to ensure uniform filling.

Carefully remove spilled concrete.

Remove shipping bolts and blocks from isolator mounts.

Jack spring leveling bolts to obtain full floating equipment suspension.

Level vibration isolator mounts and bases, to attain fully floating equipment suspension under loading conditions of actual operation and adjust restraints.

Adjust or replace defective elements as required.

After installation of isolation materials and before start-up of equipment, clear debris from areas surrounding and beneath isolated equipment.

No rigid connections between equipment and building structure shall be made that degrades noise and vibration isolation system.
Electrical conduit connections to isolated equipment shall be installed with slack to allow free motion of isolated equipment.

3.2 APPLICATION OF MOUNTING TYPES.

Mountings: Types scheduled on Drawings.

Static deflection requirements: Where not indicated, defined in ASHRAE HVAC Systems and Applications Handbook.

Ductwork located within 50 feet of connections to air handling units: Support with Type H vibration isolators selected for a static deflection of 0.75 inch.

Fans and air handling units: At flexible connections install Type K thrust restraints, where developed aerodynamic thrust exceeds 10 percent of weight, and where fan static pressure exceeds 5 inches water gauge.

End of Section

SECTION 15250

MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of insulation, jackets accessories for mechanical piping, ductwork and equipment. Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.

1.2 GENERAL. Materials furnished and installed under this section shall be in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall be responsible for coordinating the installation of insulation with the installation of the piping, ductwork, and equipment to be insulated. The piping, ductwork, and equipment shall be tested and accepted by Engineer before installation of the insulation materials.

Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.

All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL, NFPA, and ASTM safety requirements.

1.2.04 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.05 Surface Burning Characteristics. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.

1.2.06 Painting and Identification. Field painting and identification shall be as specified inMaster Specification Section 09900, Painting.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.

1.4 QUALITY ASSURANCE.

1.4.01 Manufacturer Experience. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance withMaster Specification Section 01180, Equipment, Materials, Parts, and Tools .

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.2 MATERIALS.

2.2.01 Pipe Insulation.

2.2.01.01 Type PMF1 Insulation. Type PMF1 mineral fiber pipe insulation shall be Schuller "Micro-Lok", Knauf "Pipe Insulation" Owens/Corning, or approved equal.

Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F (-18°C to 454°C), shall have a maximum thermal conductivity (k) of 0.24 BTU in/hr ft^2 °F at 75°F (0.035 W/m °C at 24°C), and shall conform to ASTM C547.

2.2.01.02 Type PMF2 Insulation. Type PMF2 high temperature mineral fiber pipe insulation shall be Fibrex "Epitherm 1200", or approved equal.

Type PMF2 pipe insulation shall be a high temperature, sectional or segmented mineral fiber forms with thermosetting binder suitable for temperatures up to 1200°F (649°C), and shall be provided in multiple layers. Fittings and valves shall be insulated with factory-made molded fiber fittings or built-up sections of pipe covering. The insulation shall conform to ASTM C547.

2.2.01.03 Type PFC1 Insulation. Type PFC1 flexible cellular elastomeric pipe insulation shall be Armstrong "Armaflex", Rubatex "R-180-FS", or approved equal. Flexible cellular polyolefin foam insulation shall be IMCOA "Imcolock" or “Imcoshield", or approved equal.

Type PFC1 pipe insulation shall be one-piece, molded elastomeric or polyolefin foam insulation suitable for a temperature range of -40°F to 210°F (-40°C to 99°C), and shall have a maximum thermal conductivity (k) of 0.28 BTU in/hr ft^2 °F at 75°F (0.040 W/m °C at 24°C). The insulation shall be suitable for exposure to weather and direct sunlight or, where not indicated to be jacketed, shall be given two coats of an ultraviolet-resistant finish recommended by the manufacturer. The insulation shall conform to ASTM C534.

2.2.02 Duct Insulation.

2.2.02.01 Type DMF1 Insulation. Type DMF1 semi-rigid type duct insulation shall be Schuller "800 Series Spin-Glas", Knauf "Insulation Board", Owens/Corning, or approved equal.

Type DMF1 exterior insulation for rectangular ductwork shall be a semirigid, 3 pound per cubic foot (48 kg/m^3) density fiberglass material with a factory-applied all service jacket. The insulation shall conform to ASTM C612.

2.2.02.02 Type DMF2 Insulation. Type DMF2 flexible type duct insulation shall be Schuller "Microlite", Knauf "Duct Wrap", Owens/Corning, or approved equal.

Type DMF2 exterior insulation for round ductwork shall be 1 pound per cubic foot (16 kg/m^3) density flexible fiberglass duct wrap with factory-applied foil-scrim-kraft facing. The insulation shall conform to ASTM C553.

2.2.03 Equipment Insulation.

2.2.03.01 Type EMF1 Insulation. Type EMF1 equipment insulation shall be Schuller "800 Series Spin-Glas", Knauf "Insulation Board", Owens/Corning, or approved equal.

Type EMF1 equipment insulation shall be rigid mineral fiber insulation board with a density of 6 pounds per cubic foot (96 kg/m^3) and a factory-applied foil-scrim-kraft facing. The insulation shall conform to ASTM C612.

2.2.03.02 Type EMF2 Insulation. Type EMF2 equipment insulation shall be Fibrex "Mineral Fiber Blanket", or approved equal.

Type EMF2 equipment insulation shall be high temperature mineral fiber blanket with a thermosetting binder suitable for temperatures up to 1200°F (649°C) and shall have a density of 8 pounds per cubic foot (128 kg/m^3). The insulation shall conform to ASTM C592.

2.3 ACCESSORIES.

2.3.01 PVC Insulation Jackets. PVC insulation jackets for piping systems shall be furnished and installed as specified herein and indicated on the drawings.

All fittings in piping systems insulated with mineral fiber shall be jacketed with a polyvinyl chloride (PVC) jacketing material. Piping systems where indicated to have PVC jackets shall be jacketed with the same PVC jacketing material. Jackets for fittings shall be one piece, factory molded to the contour of the fitting. The PVC jacket and fitting covers shall have a minimum thickness of 0.02 inches (0.51 mm) when installed indoors and 0.03 inches (0.76 mm) when installed outdoors. PVC jacketing shall be Schuller "Zeston 2000 Series", or approved equal.

2.3.02 Aluminum Insulation Jackets. Aluminum insulation jackets for insulated piping systems shall be furnished and installed as required and indicated on the drawings.

Fittings in insulated piping systems and equipment where indicated in the insulation schedule shall be provided with aluminum jackets of the same aluminum jacketing material as the piping systems. The aluminum jacket shall be Alclad 3004, or approved equal complying with ASTM B209. The jacket shall have a nominal thickness as indicated, with an embossed finish. A factory-applied asphalt and kraft paper vapor barrier or polyethylene film and kraft paper vapor barrier shall extend the full width of the jacket.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 General. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment, as required, that are not factory insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.

Seams of exposed insulation and jackets shall be in the least visible location.

3.1.02 Piping Insulation.

3.1.02.01 Type PMF1 Insulation. Pipe insulation shall be installed to cover all piping, fittings, and appurtenances. Insulation shall be full length of the factory unit using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.

Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet (4.6 m) for straight runs and not more that 6 inches (150 mm) from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.

On piping 2 inches (50 mm) and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

3.1.02.02 Type PMF2 Insulation. The insulation shall be installed in layers as required to obtain the specified thickness. Joints and seams between insulation sections or segments shall be tight and shall be staggered between layers. The insulation shall be shall be fastened with stainless steel wire loops on 6 inch

(150 mm) centers embedded into the outer layer. All cracks, voids, and depressions shall be filled with insulating cement suitable for the system operating temperatures. The surfaces to receive outer coverings shall be smooth and uniform. Flanges and expansion joints in exhaust piping shall not be insulated.

3.1.03 Duct Insulation. Insulation for ducts indicated on the drawings as wrapped shall be installed as specified herein and indicated on the drawings. Duct insulation shall be continuous through hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.

Insulation on ducts conveying air at temperatures below 60°F (16°C) shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.

3.1.03.01 Type DMF1 Insulation. Type DMF1 semirigid insulation shall be secured to all four sides of the duct with mechanical fasteners, spaced not more than 12 inches (305 mm) apart and not more than 3 inches (76 mm) from the edges of the insulation joints. At least two rows of fasteners shall be provided for each side of 12 inch (305 mm) and larger ducts, and one row for each side of ducts smaller than 12 inches (305 mm). All joints in the insulation shall be sealed with 3 inch (76 mm) wide joint sealing tape or 4 inch (102 mm) wide strips of jacket material secured with adhesive and staples.

3.1.03.02 Type DMF2 Insulation. Type DMF2 flexible insulation shall be installed with waterproof, fire-retardant adhesive. Insulation jackets shall overlap at least 2 inches (51 mm) and shall be secured under the overlap with adhesive and stapled on 4 inch (102 mm) centers.

3.1.04 Equipment Insulation. Insulation for equipment shall be installed as specified herein and indicated on the drawings. Equipment insulation shall be installed and fastened as recommended by the manufacturer.

Equipment insulation shall be installed in as closest contact possible with the equipment surface and shall be secured with studs, pins, clips, adhesives, wires, or bands. Pumps may be insulated by forming a box around the pump housing. Seams shall be sealed with joint sealing tape. A smooth coat of insulation cement shall be applied over the insulation except at removable sections. On equipment with surface temperatures lower than 60°F (16°C), two coats of vapor barrier coating shall be applied.

Equipment insulation shall be applied with interruptions for access to manholes, flanges, and other openings without disturbing the insulation. Boxouts with beveled and sealed edges shall be provided around code stamping symbols and nameplates.

3.1.05 PVC Jacketing. PVC jacketing for piping systems shall be installed as specified herein and indicated on the drawings. End joints and longitudinal seams on piping systems conveying fluids at lower than ambient temperatures shall be vapor-sealed, and covered with vapor-barrier tape to ensure a continuous vapor seal. Fittings shall be insulated with glass fiber material.

3.1.06 Aluminum Jacketing. Aluminum jacketing for piping systems shall be installed as specified herein and indicated on the drawings. Jacketing shall be held in place with stainless steel securing bands uniformly spaced at not more than 18 inches (457 mm) to produce tight joints without "bulging". The jacket shall overlap at least 2 inches (51 mm) at longitudinal and circumferential joints. Joints shall be overlapped and sealed with caulk to prevent moisture penetration, and longitudinal joints shall be placed to shed water. Exposed ends of pipe insulation shall be provided with covers constructed of the same material as the jacketing.

Elbows shall be jacketed with spirally wrapped aluminum strips or individual mitered segments or gores cut to fit the insulation.

3.2 INSULATION SCHEDULE.

INSULATION SCHEDULE				
Service	Size Inches (mm)	Mechanical Insulation		Notes
		Type	Thickness Inches (mm)	
PIPING - INDOOR (CONCEALED OR EXPOSED)				
Chilled Water	All	PMF1	1 (25)	(3)
Compressed Air	All	PMF1	1 (25)	(2)
Condensate Drain	All	PMF1	1 (25)	(4)

Digester Gas	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1 (25) 2 (50)	
Engine Exhaust	All	PMF2	Note (8)	
Gaseous Oxygen	All	PFC1	2 (50)	
Heating Water, Steam, and Steam Condensate	Up to 3/4 (20) 1 to 2 (25 to 50) 2.5 to 4 (65-100) 6 & 8 (150-200) 10 (250) & larger	PMF1 PMF1 PMF1 PMF1 PMF1	1-1/2 (40) 1-1/2 (40) 2 (50) 2-1/2 (65) 3 (80)	(3) (3) (3) (3) (3)
NaOH, $FeCl_3$ Without Heat Tracing	All	PMF1	1 (25)	(2)
Potable Cold Water	Up to 3 (80) 4 (100) & larger	PFC1 PFC1	3/4 (20) 1/2 (15)	(4) (4)
Potable Hot Water	All	PMF1	1 (25)	
Process Air, Nitrogen, and Gaseous Oxygen From VPSA System Including Piping From Blower Inlet Filter To Ozone Generator Inlet and Common Header From VPSA and LOX	Up to 6 (150) Larger than 6 (150)	PMF1 PMF1	1 (25) 2 (50)	(2) (2)
Refrigerant Suction	Up to 1 (25) 1-1/4 (32) & larger	PFC1 PFC1	3/4 (20) 1 (25)	(3) (3)

Sludge	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1-1/2 (40) 2 (50)	(3) (3)
Storm Drain	All	PFC1	3/4 (20)	(4), (9)
PIPING - OUTDOOR (EXPOSED)				
Compressed Air	All	PMF1	1 (25)	(2), (5)
Digester Gas	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1 (25) 2 (50)	
Fuel Oil	All	PMF1	1-1/2 (40)	
Gaseous Oxygen	All	PFC1	2 (50)	
NaOH, $FeCl_3$ Without Heat Tracing at 60°F+	All	PMF1	1 (25)	(2)
NaOH, $FeCl_3$ Without Heat Tracing at 30°F+	All	PMF1	1-1/2 (40)	(2)
NaOH, $FeCl_3$ Without Heat Tracing at 0°F+	All	PMF1	2 (50)	(2)
Process Air	All	PMF1	1 (25)	
Refrigerant Suction	All	PFC1	1 (25)	(2)
Sludge	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1-1/2 (40) 2 (50)	(2) (2)
DUCTWORK				
Rectangular	All	DMF1	1 (25)	(6), (7)

Round	All	DMF2	2 (50)	(6), (7)
EQUIPMENT				
Air Separators	All	EMF1	1-1/2 (40)	
Chilled Water Pumps	All	EMF1	1-1/2 (40)	
Engine Silencer	All	EMF2	Note (8)	
Expansion Tanks	All	EMF1	1-1/2 (40)	
Heating Water Pumps	All	EMF1	1-1/2 (40)	

Mechanical Insulation Types: FC - Flexible Cellular
MF - Mineral Fiber

Notes:

(1) PVC jacket.

(2) Aluminum jacket.

(3) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet (2.4 m) above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.

(4) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.

(5) Insulation shall be provided for exposed portions of the piping system located less than 8 feet (2.4 m) above the finished floor or grade.

(6) Insulation shall be provided for outside air plenums and ducts with heating coils which are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.

(7) Insulation shall be provided for air conditioning supply ducts, air

conditioning return ducts, and dehumidifier reactivation air discharge ducts, unless indicated to be internally lined.

(8) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F (66°C).

(9) The underside of all roof drains shall be insulated to a 1 foot (300 mm) radius from the center of the drain. All roof drain piping within 4 feet (1.2 m) of the drain shall be insulated.

Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F (60°C) and below 60°F (15°C) shall be insulated.

End of Section

SECTION 15300

FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of materials, equipment, and appurtenances associated with wet-pipe and dry-pipe fire sprinkler systems. All labor, materials, tools, equipment, service and supervision required to design, install, test, and place the fire sprinkler systems in service shall be provided.

Fire sprinkler systems shall meet the design conditions and features as specified and as indicated on the drawings.

1.2 GENERAL.

1.2.01 Coordination. Piping, equipment, and appurtenances furnished and installed under this section shall be designed, fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations furnished by the manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the fire sprinkler system is compatible with all other parts of the system; that all piping, equipment, and appurtenances are appropriate for the intended function; and that all devices necessary for a properly functioning system have been provided.

Equipment and appurtenances furnished under this section shall be the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the products of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall become familiar with details of the work, shall verify dimensions in the field, and notify Engineer of any discrepancy before performing the work.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with the applicable national, state, and local codes and ordinances, laws, regulations, and NFPA Standards which pertain to such work. In case of a conflict between these specifications and any applicable national, state, or local code, ordinance, law, regulation, or NFPA Standard, the latter shall govern.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming a part of the equipment and appurtenances furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

The data and specifications submitted shall include, but not be limited to, the following:

Design Documents

Complete working plans, hydraulic calculations, water supply data, and information required by NFPA Standards.

Equipment, Piping, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection type, size, and location.

Wiring diagrams.

Pressure loss data.

Net weight.

Test Reports

Test reports and certificates as described in NFPA Standard No 13.

1.3.02 Operation and Maintenance Manuals. Operation and maintenance instructions shall be provided for the equipment and appurtenances furnished under this section.

1.4 QUALITY ASSURANCE. All materials and work shall conform to the requirements of the National Fire Protection Association (NFPA), Factory Mutual (FM), and Underwriters' Laboratories (UL).

Manufacturer's providing equipment and appurtenances shall be listed by product name and manufacturer in the UL Fire Protection Equipment Directory and FM Approval Guide.

Fire sprinkler system materials shall be permanently stamped or labeled with the Listing and Approval Agency's identification.

Materials, installation, inspection, and testing of the fire sprinkler system shall comply with the requirements of the local authorities having jurisdiction and Owner's insurance underwriter.

The sprinkler system drawings and calculations shall be performed by an individual with National Institute for Certification of Engineering Technologies (NICET) III certification and signed and sealed by a registered professional engineer licensed in the state of Michigan.

The fire sprinkler system shall be installed by a firm having previously installed a minimum of five systems similar in size and scope to this project.

1.5 PERFORMANCE AND DESIGN REQUIREMENTS. All piping, equipment, and appurtenances shall be designed to meet the performance and design conditions as specified herein and on the drawings. The system shall be designed as an automatic wet-pipe or automatic dry-pipe sprinkler system as indicated in Schedule 13930-S01. The system type, zoning, hazard classification, sprinkler density, and design area of operation shall be as indicated on the drawings, or on schedules, as indicated.

The design area represents the minimum area to be considered for hydraulic calculations. The system shall be designed to discharge the sprinkler density over the most hydraulically demanding design area. The area required to be sprinkled may be larger than the design area.

Water allowances shall be made for inside or outside hose streams as required. Hose stream flow rates shall be as specified by NFPA Standards.

1.5.01 Flow Test. Sprinkler system design shall be performed using either data from a test performed by Contractor, or data supplied by Engineer.

When indicated, Contractor shall perform a water flow test to verify that adequate pressure is available at the required flow before the system is designed. Water supply information provided on the data sheet is based on estimates and shall be verified by flow test prior to designing the sprinkler system. The verification flow test and data shall be the responsibility of Contractor. If it is not possible to perform a flow test prior to designing the system, the test may be performed later, however, Contractor shall accept responsibility for any modifications required in the event that the flow tests indicate a lower available water supply than that on which the calculations were based.

1.5.02 Pipe Sizing. The sprinkler system shall be hydraulically calculated, and shall include a safety factor as indicated at the required flow.

Pipe and accessory sizes indicated on the drawings are the minimum allowed, and shall be increased if determined necessary by hydraulic calculations. The water velocity in piping systems shall not exceed 20 fps (6.1 m/s) at design flow.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.7 EXTRA MATERIALS. A supply of spare sprinklers shall be provided in accordance with NFPA Standard No 13. The sprinklers shall be stored in a suitable metal container and shall be representative of the number of each type and each temperature rating of the sprinklers installed.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment identification, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All components of the fire sprinkler system shall be designed to meet the specified conditions indicated in the Contract Documents.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as indicated in the respective product description paragraphs.

2.3 MATERIALS. All piping systems and related components shall be rated for at least 175 psig (1207 kPa) working pressure.

2.3.01 Anchor Bolts and Expansion Anchors. All anchor bolts, expansion anchors, nuts and washers shall comply with UL, FM, and NFPA requirements. Powder-driven anchor assemblies shall not be used.

2.3.02 Piping Systems. Piping on the supply side of the backflow prevention device shall be as specified in other sections for potable water use. Piping on the sprinkler side of the backflow prevention device shall be black or galvanized steel pipe as follows:

Standard Weight ASTM A53 with Threaded Malleable or Cast Iron Fittings.

All 2 inch (51 mm) and smaller piping.

Standard Weight ASTM A53 with Flanged Fittings.

All 2-1/2 inch (63 mm) and larger piping.

Standard Weight ASTM A53 with Grooved-End Fittings.

All 2-1/2 inch (63 mm) and larger piping on the sprinkler side of the backflow preventer. (Optional)

Schedule 10 ASTM A135 with Roll-Grooved Fittings.

All 2-1/2 inch (63 mm) and larger piping on the sprinkler side of the backflow preventer. (Optional)

Galvanized steel pipe shall be used for sprinkler piping in the systems and locations as required. Pipe shall be furnished complete with all fittings, jointing materials, supports and anchors, and other accessories required for a complete system.

Plain-end fittings with mechanical devices which grip into the pipe, and saddle type branch fittings shall not be used.

2.3.03 Pipe Supports. Pipe supports shall be suitable for the application, construction, and type and size of pipe used.

"C" type clamps shall be provided with retaining clips and shall not be used for piping larger than 1 inch (25 mm) size.

Galvanized hanger assemblies shall be used for the support of galvanized steel piping systems.

2.3.04 Service Valves. Service valves shall be UL-listed and FM approved, with 175 psig (1207 kPa) non-shock minimum working pressure rating.

2.3.04.01 Gate Valves. Gate valves in 2 inch (51 mm) and smaller sizes shall be cast-bronze with threaded ends, solid wedge disc, outside screw and yoke, and rising stem.

Gate valves in 2-1/2 inch (63 mm) and larger sizes shall be iron body, bronze mounted, with tapered solid wedge disc, outside screw and yoke, and rising stem. Valves shall be provided with replaceable bronze disc facing rings and flanged ends.

Gate valves in 4 inch (102 mm) and larger sizes for use with indicator posts shall be iron body, bronze mounted, with solid wedge disc, non-rising stem, operating nut, replaceable bronze disc facing rings, and bonnet cap for indicator post. Gate valves for use with wall indicator posts shall be provided with flanged ends. Gate valves for use with vertical indicator posts shall be provided with flanged or mechanical joint ends.

Indicator posts shall be wall type or vertical type, as indicated. When indicated, the indicator post shall be provided with a supervisory switch to alarm when the valve is not in the full open position.

Wall type indicator posts shall be with cast-iron body, windows for target plates that indicate valve position, extension rod and coupling, locking device, hand wheel operator, wall flange, and red enamel finish.

Vertical type indicator posts shall be with cast-iron body, ductile iron barrel, windows for target plates that indicate valve position, extension rod and coupling, locking device, operating wrench, and red enamel finish. The indicator post shall be of suitable length for the water main bury depth, with the operating handle located approximately 3 feet (900 mm) above finish grade.

2.3.04.02 Butterfly Valves. Butterfly valves in 3 inch (76 mm) and larger sizes shall be provided with cast iron body, iron or aluminum/bronze disc, BUNA-N or EPDM seat sleeve. Valve body shall be lug or grooved type as determined by the piping system. Butterfly valves shall be provided with an integral indicator to show disc position. The indicator shall include a pre-wired single-circuit supervisory switch rated for 10 amperes ac.

2.3.04.03 Ball Valves. Ball valves in 2 inch (51 mm) and smaller sizes shall be brass ball and body with reinforced Teflon seat and threaded ends.

2.3.04.04 Check Valves. Swing check valves 2-1/2 inch (63 mm) and larger shall be cast-iron body with bolted cap, bronze disc or cast-iron disc with bronze disc ring, and flanged ends.

2.3.05 Specialty Valves. Specialty valves shall be UL-listed and FM approved, with 175 psig (1207 kPa) non-shock minimum working pressure rating.

2.3.05.01 Alarm Check Valve. When an alarm check valve is indicated, it shall be provided with variable pressure trim and standard accessories including pressure gauges; alarm switch with contacts rated for 120 volts, 10 amperes; testing bypass;

drain cup; retarding chamber; and all necessary pipe, fittings, and accessories required for a complete trimming installation in accordance with NFPA No. 13. The valve shall be provided with flanged inlet and outlet, bronze grooved seat with O-ring seals, and single hinge pin and latch design. The alarm switch shall be wired to the fire alarm system.

2.3.05.02 Dry-Pipe Valve. When a dry-pipe valve is indicated, it shall be a latching differential valve and shall be provided with standard accessories including drip check valve; drain cup; reset bar; alarm test shut-off valve; pressure gauges; alarm switch with contacts rated for 120 volts, 10 amperes; testing bypass; and all necessary pipe, fittings, and accessories required for a complete trimming installation in accordance with NFPA No. 13. The valve shall be provided with flanged inlet and outlet, bronze grooved seat with O-ring seals, and single hinge pin and latch design. The alarm switch shall be wired to the fire alarm system.

An accelerator, anti-flood device, and associated trim package shall be provided with each dry-pipe valve.

2.3.05.03 Deluge Valve. The system deluge control valve shall be a listed indicating type valve. The control valve shall be UL listed and Factory Mutual (FM) approved for fire protection installations. The system control valve shall be rated for normal system pressure but in no case less than 175 psi. Acceptable manufacturers shall be Viking, Victaulic or approved equal.

The system valve shall be cast-iron body, hydraulically operated, differential-pressure type. Include bronze seat with O-ring seals, trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from drain line, fill-line attachment with strainer, and push-rod chamber supply connection.

Water Control Valve: The deluge system shall utilize a 90° pattern or straight type of deluge valve shall be externally resettable by hydraulic means. The deluge valve shall employ a positive vent on the priming line to ensure that the deluge valve will not prematurely reset. The inlet and outlet connections of deluge valve can be flanged by flanged, flanged by grooved or grooved by grooved, respectively. The deluge valve shall be capable of installation in the vertical or horizontal position. The deluge valve shall be UL Listed and Factory Mutual Approved. The deluge valve shall have a working pressure of 250 PSI. The valve trim shall be compatible and shall be installed following the manufacturer's specifications. The Deluge Valve manufacturer shall be Viking E-1 or F-1 series or approved equal.

Water Control Valve Trim: The deluge valve trim shall incorporate a pressure operated relief valve (PORV) of the same manufacturer as the deluge valve, to provide a hydraulic means to positively vent the priming water chamber. All deluge valve trim piping and devices shall be listed for use as deluge system. The deluge valve trim shall be galvanized and rated for 250 PSI working pressure. The Deluge Valve Trim shall be compatible with Viking E-1 or F-1 deluge valve, or approved equal.

Water Control Valve Release Panel: The deluge valve release panel shall be 120 VAC or 220 VAC powered with a 24 hour D/C backup power supply. The deluge valve release panel shall be capable of accepting cross-zoned detection as the means of system release. The deluge valve release control panel shall conform to NFPA 70, NFPA 72 and all other applicable codes. The deluge valve release control panel shall be listed for use with a Viking Model E-1 or F-1 deluge valve. The Deluge Release Panel shall be a Simplex-Grinnell, Viking, or approved equal.

Solenoid Valve: An electric solenoid valve shall be utilized to release the priming chamber water pressure. The solenoid valve shall be 24 VAC and conform to NFPA 70. The Solenoid shall be listed for the use with Viking Model E-1 or F-1deluge valve, or approved equal.

Discharge Devices: Nominal 1/2-inch orifice for “Ordinary” temperature classification rating, unless otherwise indicated or required by application.

Open Sprinklers: UL 199, without heat-responsive element.

Orifice: 1/2-inch, with discharge coefficient K between 5.3 and 5.8.

Orifice: 17/32-inch, with discharge coefficient K between 7.4 and 8.2.

Supplemental Detection System: Electrical devices utilized in the supplemental detection system shall be compatible with the release control panel. Installation of electrical supplemental detection system shall be in accordance with N.F.P.A. 70, NFPA 72 and local installation requirements. The detection system shall be inspected, tested and maintained in accordance with all applicable standards and codes.

System Piping: System piping shall conform to NFPA 13, Standards for Installation of Sprinkler Systems. System piping shall be listed for the maximum system pressure it is to be exposed to. All system piping shall be metallic and shall be protected against corrosion of corrosive exist.

Hangers: Deluge sprinkler system hangers shall conform to NFPA 13, Standards for Installation of Sprinkler Systems. The system piping shall be substantially supported to prevent sway or thrust. The hanging of no-system components from the sprinkler piping shall be strictly prohibited. The use of non-metallic hanger materials shall be prohibited unless expressed otherwise.

Fittings: Pipe fittings installed on the deluge sprinkler system shall be in conformance with NFPA 13, Standards for Installation of Sprinkler Systems. The fittings shall be listed for use at the system pressures to be encountered. Fittings shall be corrosion resistant if they are to be installed in a corrosive atmosphere.

2.3.05.04 Air Maintenance Device. An air maintenance device shall be provided for each dry-pipe system. The air maintenance device shall be furnished as a complete assembly, including pressure regulator, pressure relief valve, strainer, shut-off valves, bypass valve, check valve, restriction device, and associated piping. The pressure reducing valve and pressure relief valve settings shall be suitable for the water system supply pressure.

2.3.05.05 Ball Drip Valves. Ball drip valves shall be automatic drain type, 3/4 inch (19 mm) body size, with spring-loaded ball check device and threaded ends.

2.3.05.06 Backflow Preventer. The sprinkler system backflow preventer shall be a double check, double check detector, reduced pressure principle, or reduced pressure detector type as required. The unit shall be epoxy-coated cast iron, with bronze seat and stainless steel trim. Gate valves with flanged ends, outside screw and yoke, rising stem, and resilient seats shall be factory installed at each end of the unit. Each gate valve shall be provided with a supervisory switch to alarm in the event that the valve is not in the full open position.

Detector type backflow preventers shall have a bypass consisting of a bronze displacement type water meter in series with a bronze backflow preventer with ball valves on the bypass line. The backflow preventer on the bypass line shall be double check or reduced pressure principle type as needed to match the primary unit. Backflow preventers shall be as manufactured by Febco, Watts Industries, Inc., or approved equal.

2.3.06 Automatic Sprinklers. Sprinklers shall be furnished and installed in accordance with their listed spacing limitations. Automatic sprinklers shall be provided with heat responsive elements conforming to UL 199. Sprinkler types and categories shall be as indicated in Schedule 13930-S01 or other location as required. Sprinklers shall be provided with nominal 1/2-inch orifice and 165°F (74°C) temperature rating unless otherwise indicated or required by application. Sprinklers located in the vicinity of heaters shall be provided with intermediate or high temperature ratings as specified by NFPA 13.

Sprinklers shall be furnished and installed with all required escutcheons for a complete installation. Escutcheons shall permit sprinkler head adjustment as needed for a proper installation.

Sprinkler cabinets shall be finished steel with hinged cover, space for minimum of 6 spare sprinklers plus sprinkler wrench, and shall be suitable for wall mounting.

Include number of sprinklers required by NFPA 13 and 1 wrench for sprinklers. A separate cabinet with sprinklers and wrench shall be provided for each style of sprinkler head on this project.

When indicated in Schedule 15300-S01, wire-cage type sprinkler guards shall be provided with fastening device for attaching to sprinkler.

2.3.07 Fire Department Connection. A sprinkler system fire department Siamese connection shall be provided when indicated on drawings. The location of the connection shall be as indicated on the drawings or as approved by Engineer and the local Fire Department. The type of siamese connections shall be wall-type or freestanding type as required.

Wall-type fire department connections shall be flush or a projecting type, as required, with cast-brass body; polished chrome plated finish; NH-standard thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS outlet. Connection shall include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet; and round wall escutcheon plate with marking "AUTO SPKR". The connection shall be provided with two 2-1/2 inch (65 mm) inlets and one 4 inch (100 mm) back outlet.

Freestanding type fire department connections shall be cast-brass or polished brass, as required, with angle body, polished brass cover sleeve, NH-standard thread inlets according to NFPA 1963 and matching local fire department threads, and threaded NPS outlet. Connection shall include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet, and cast brass identification nameplate with marking "AUTO SPKR". The connection shall be provided with two or three 2-1/2 inch (65 mm) inlets and one 4 inch (100 mm) or one 6 inch (150 mm) outlet, as required.

2.3.08 Alarm Devices. Alarm devices shall be provided as indicated. Alarm device type and size shall be as needed to match piping and equipment connections.

Water flow indicators shall be electrical supervision vane type, rated to 250 psig (1724 kPa gauge), and shall comply with UL 346. The indicators shall be furnished with a pipe saddle and cast aluminum housing, and shall be suitable for horizontal or vertical installation. Two spdt circuit switches shall be provided with isolated alarm and auxiliary contacts. Contacts shall be rated for 7 ampere, 125 V ac and 0.25 ampere, 24 V ac. Water flow indicators shall be complete with factory-set, field-adjustable, instantly recycling pneumatic retard element to prevent false signals, and tamper-proof cover that alarms when cover is removed.

Pressure switches shall be electrical supervision type, with spdt contacts, and shall comply with UL 753. The pressure switches shall be designed to signal water flow based on rising pressure.

Supervisory (tamper) switches shall comply with UL 753, and shall be electrical supervision type, with spdt normally closed contacts. The switches shall be designed to signal when the controlled valve is in other than full open position and if switch is removed or dismantled.

The sprinkler water flow alarm shall be water motor or electric type.

Water motor alarms shall be hydraulically operated outdoor alarm type. The water motor alarm shall be provided with an aluminum alloy alarm gong at least 5 inches in diameter, energy-efficient impeller, and bearings which do not require lubrication. A Y-strainer shall be installed in the alarm pipeline. The alarm shall be initiated by flow from the alarm check valve retarding chamber, dry-pipe valve, or deluge valve as required.

Electric water flow alarms shall be outdoor alarm bell type, with an aluminum alloy alarm gong at least 6 inches in diameter. The alarm bell shall be weatherproof, and shall be suitable for a 120 V ac power supply. The alarm shall be initiated by flow through the alarm check valve retarding chamber, dry-pipe valve, deluge valve, or flow switch.

2.3.09 <u>Air Compressor</u>. The system air compressor shall be oil-less, permanently lubricated, direct drive, with filtered air inlet and safety relief valve, and suitable for pipeline mounting. System pressure and compressor capacity shall be as required or as specified by NFPA based on the volume of the system, whichever is more stringent. The compressor motor shall be suitable for the power supply. An individual compressor shall be provided for each dry pipe system.

2.3.10 <u>Pressure Gauges</u>. Pressure gauges shall comply with UL 393, and shall be provided with 3-1/2 inch (89 mm) to 4-1/2 inch (114 mm) diameter dial, and a dial range of 0-250 psig (0-1724 kPa gauge).

2.3.11 <u>Emergency Break Glass Switch</u>. Each break-glass switch for fire sprinkler system shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Square D "Type 9001K15", Cutler Hammer 10250T Series, or approved equal, with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

2.4 <u>CONSTRUCTION</u>.

2.4.01 <u>Shop Coating</u>. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

PART 3 - EXECUTION

3.1 INSPECTION. Contractor shall field verify all existing conditions prior to designing the system.

3.2 INSTALLATION. Piping, equipment, and appurtenances furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.2.01 Sprinkler Piping and Accessories. Deviations from approved "working plans" for sprinkler piping require recalculation and approval by authority with jurisdiction. Written approval shall be obtained from Engineer prior to deviating from approved "working plans".

Approved fittings shall be used to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Unions shall be installed adjacent to each valve in pipes 2 inch (51 mm) and smaller. All piping shall be hidden from view in areas with finished ceilings and other areas, as indicated, unless accepted by Engineer to be exposed.

"Inspector's Test Connections" shall be installed in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

The sprinkler piping shall be installed with drains for complete system drainage. Ball drip valves shall be installed to drain piping between fire department connections and check valves, and where indicated. Route drain to outside the building unless otherwise indicated on the drawings.

The sprinkler head riser drop lengths shall be determined in the field and shall be coordinated with all ductwork, electrical conduit, piping systems, process equipment, and tanks. If the sprinkler system piping is installed before all ductwork or other building system construction is finished and if any sprinkler head risers need to be relocated to meet the code requirements, Contractor shall extend or relocate the risers and sprinkler heads at his expense.

Hanger and support spacing and locations for steel piping joined with grooved mechanical couplings shall be in accordance with the manufacturer's written instructions for rigid systems.

Metal roof decking shall not be used for the support of equipment or piping.

Pressure gauges shall be installed at each sprinkler test connection and at top of each riser. Pressure gauges shall be provided with connections not less than 1/4 inch (7 mm) and with soft metal seated globe valve arranged for draining pipe between gage and valve. Gauges shall be installed to permit removal and shall not be installed where subject to freezing.

All alarm devices shall be connected to the fire alarm, plant control, or other system as required.

When they are specified, the water motor alarm bell or electric alarm bell shall be mounted outside on an exterior wall of the building at a location suitable to Engineer so personnel in the area will notified when an alarm is sounded.

3.2.02 Sprinkler Valves. Fire sprinkler valves shall be installed with all trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the authority having jurisdiction.

Service valves shall be supervised-open, and located to control sources of water supply except from fire department connections. Provide permanently marked identification signs indicating portion of system controlled by each valve.

Alarm check valves shall be installed in the vertical position for proper direction of flow, including bypass check valve and retard chamber drain line connection.

All double-check detector assembly backflow preventers shall be installed with bypass water meter, gate valves on each side of meter, and check valve downstream from the meter.

All reduced pressure detector assembly backflow preventers shall be installed with bypass water meter, gate valves on each side of meter, and reduced pressure backflow preventer downstream from the meter.

3.3 FIELD TESTING. Field testing of the fire sprinkler systems shall conform to the requirements of NFPA 13 "System Acceptance" Chapter and to the requirements of the local Fire Department.

Engineer and a representative of the local Fire Department will witness all tests. Contractor shall arrange the testing schedule with the Fire Department and Engineer; with at least 7 days' advance notice.

Contractor shall replace piping and components that do not pass the test procedures specified, and then retest to demonstrate compliance. The procedure shall be repeated until satisfactory results are obtained at no additional cost to Owner. Three copies of test reports shall be submitted in writing to Engineer and to the Fire Department.

Test certificates shall be executed and submitted prior to final inspection and acceptance in accordance with the requirements of NFPA No. 13. Three copies of each test certificate shall be furnished to Engineer and the Fire Department.

After installation and testing of the fire suppression system, complete drawings, conforming to installation records, including location of sprinkler heads, control valves, water supply connections, and wiring diagrams shall be submitted to Engineer prior to final acceptance.

3.4 <u>ADJUSTING</u>. All alarm devices shall be adjusted for proper operation. All drains shall be checked for proper operation.

3.5 <u>CLEANING</u>. Immediately prior to the final inspection, equipment, piping and appurtenances shall be thoroughly cleaned. Dirt and debris shall be cleaned from sprinklers. Sprinklers having paint other than factory finish shall be replaced with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.6 <u>FINAL INSPECTION AND ACCEPTANCE</u>. A decision shall be reached during the inspection concerning the resolution of discrepancies and changes as recommended by the authorities having jurisdiction. All work determined to be the responsibility of Contractor, and included within the scope of the specifications, shall be promptly completed at no expense to Owner.

The final acceptance of the fire sprinkler system shall be made after the completion of the corrective work resulting from the final testing and inspection and after receipt of a formal letter of acceptance from the local Fire Department.

End of Section

SECTION 15310

CLEAN AGENT FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of materials, equipment, controls, wiring, and appurtenances associated with the clean agent fire suppression system as indicated herein and on the drawings.

The Work shall include furnishing all labor, materials, tools, equipment, service and supervision required to design, install, test, and place into service the fire suppression system throughout the rooms and buildings as indicated in the Contract Documents.

1.2 GENERAL.

1.2.01 Coordination. Piping, equipment, controls, wiring, and appurtenances furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the fire suppression system is compatible with all other parts of the system; that all piping, equipment, wiring, and appurtenances are appropriate for the intended function; and that all devices necessary for a properly functioning system have been provided.

Equipment and appurtenances furnished under this section shall be the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall become familiar with details of the work, shall verify dimensions in the field, and notify Engineer of any discrepancy before performing the work.

1.2.02. General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with the applicable national, state, and local codes and ordinances, laws, regulations, and National Fire Protection Association (NFPA) Standards which pertain to such work. In case of a conflict between this section and any applicable national, state, or local code, ordinance, law, regulation, or NFPA Standard, the latter shall govern.

NFPA standards to be followed shall include, but not limited to:

NFPA 2001	Clean Agent Fire Extinguishing System
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm Code

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, working plans, flow calculations, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment and appurtenances furnished, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Device tag numbers indicated on the contract drawings shall be referenced on the submittals where applicable. The submittal to Engineer shall be made after the local authorities having jurisdiction have approved the design. The data and specifications shall include, but not be limited to, the following:

Design Documents

Complete working plans and flow calculations with information as specified by NFPA Standard No 2001.

Fire Suppression Agent

Complete description of suppression agent including physical characteristics, limitations on use, handling procedures and safety precautions.

Equipment, Piping, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

ASTM specification for pipe and fittings.

Overall dimensions.

Pressure loss data

Net weight.

Control, Detection, Alarm, and Actuation System

Name of manufacturer.

Type and model.

Control panel face layout.

Sequence of Operation.

Wiring diagrams.

Power requirements.

Test Reports

Test reports indicating successful completion of tests specified herein and as specified by NFPA Standard No. 2001.

1.3.02 Operation and Maintenance Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE. All materials and work shall conform to the requirements of NFPA and Underwriters' Laboratories (UL), and shall be permanently stamped or labeled with the Listing Agency's identification.

Materials, installation, inspection, and testing of the fire suppression system shall comply with the requirements of the local authorities having jurisdiction and Owner's insurance underwriter.

Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of clean agent fire extinguishing systems. All products shall be new and of the latest manufacture. Equipment shall be supported by a service organization that is, in the opinion of Engineer, reasonably convenient to the site.

The suppression system drawings and calculations shall be performed by an individual who is certified Level II or greater by The National Institute for Certification in Engineering Technologies (NICET) in the subfield of Fire Protection Engineering Technology, Special Hazards System Layout. When indicated, the work shall be supervised and the drawings signed and sealed by a registered professional engineer licensed in the state of Michigan.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The system shall cover only the interior locations of the building as herein specified; and shall be suitable for the building construction type, room temperature range, and contents. The contents and temperature range of the area to be protected shall be as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The clean agent fire suppression system shall be designed as a single-shot, automatic-manual, total flooding system. The suppression system shall be listed as a pre-engineered system. The system shall be provided with primary suppression agent cylinders in the quantity and location as indicated on the drawings. Reserve cylinders shall be provided as indicated in the Contract Documents.

The fire extinguishing system shall provide a concentration of fire extinguishing agent to create an atmosphere that will not support combustion when discharged in the protected areas. The discharge time for halocarbon agents shall not exceed 10 seconds. The discharge time for inert gas agents shall not exceed 60 seconds. The system design shall include the capacity to automatically maintain the design concentration for a minimum of 10 minutes, or as specified by NFPA, whichever is more stringent. A suitable allowance in agent quantity shall be made for normal leakage of agent from the spaces due to agent expansion.

2.2.01 Elevation. All components of the fire suppression system shall be designed to operate at the elevation indicated in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable agents include heptafluoropropane (FM-200) as manufactured by Great Lakes Chemical Corporation, FE-13 as manufactured by DuPont Chemicals, and INERGEN as manufactured by ANSUL Fire Protection, or approved equal.

2.4 CONSTRUCTION.

2.4.01 General. Materials and equipment shall be as specified below and as shown and shall be suitable for the service intended. Materials and equipment shall satisfy the requirements of NFPA 2001. Devices and equipment used for the same or similar services shall be of the same make and type and shall be interchangeable when of the same rating.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

All anchor bolts, expansion anchors, nuts and washers shall comply with UL, FM, and NFPA requirements. Powder-driven anchor assemblies shall not be used.

2.4.03 Piping Systems. Distribution piping shall be black or galvanized steel, either ASTM A53 seamless or electric welded, Grade A or B or ASTM A-106, Grade A, B, or C. Cast-iron pipe, steel pipe conforming to ASTM A 120, or nonmetallic pipe shall not be used. Pipe shall be furnished complete with all fittings, jointing materials, supports and anchors, and other accessories required for a complete system.

2.4.04 Pipe Fittings. Pipe fittings for FM-200 and FE-13 agents shall have a minimum working pressure of 620 psi (4280 kPa). Pipe fittings for INERGEN agent shall have a minimum working pressure downstream of the pressure reducer of 1,000 psi (6900 kPa). Cast iron and Class 150 lb steel fittings shall not be used.

2.4.05 Pipe Supports. Pipe supports shall be suitable for the application, construction, and type and size of pipe involved. "C" type clamps shall not be used for larger than 1 inch (25 mm) diameter piping, and shall be provided with retaining clips. Galvanized hanger assemblies shall be used for the support of galvanized steel piping systems.

2.4.06 Storage Containers. Agent containers shall meet the requirements of NFPA 2001. Containers shall be fitted with a resilient pressure seat type forged brass valve and shall have a threaded steel anti-recoil protective cap for handling and shipment.

Storage containers and any pressurized release containers shall be equipped with pressure switches that shall initiate a supervisory signal when cylinder pressure in a container drops to 90 percent of the system working pressure. A portable direct reading beam scale shall be provided for weighing FM-200 and FE-13 containers in place by loosening cylinder clamps and disconnecting the discharge heads. It shall not be necessary to disconnect any control components. Liquid level indicators may be provided in lieu of the portable direct reading beam scale. The containers shall be arranged to allow a service aisle for cylinder removal and cylinder weighing.

Container racks shall be provided at all installations. Racks shall be designed to rigidly secure all containers in place.

2.4.07 Discharge Valve. Each cylinder shall be fitted with a pressure operated discharge valve. Each valve shall include an integral safety relief device which serves to protect cylinder against excessive internal pressure. The cylinder valve shall have a forged brass body with external connections for actuation devices. Each valve shall be provided with a removable pressure gauge or solenoid valve with gauge for pressure reading. When more than one cylinder is connected to a common manifold, a check valve shall be provided with each cylinder. Check valves that utilize "O" ring seats shall not be used as they can be dislodged during discharge.

2.4.08 Discharge Nozzles. Nozzles shall be supplied in quantities sufficient to properly cover the areas being protected in accordance with NFPA 2001. Nozzles shall be of corrosion resistant construction and shall be designed specifically for clean agent application. Nozzles shall be permanently marked as to type and orifice size.

2.4.09 Caution/Advisory Signs. The fire suppression system contractor shall provide signs as specified by NFPA 2001 and as recommended by the clean agent manufacturer. As a minimum, the following signs shall be provided:

A caution sign on the outside of each exterior door of the protected area. Sign shall be Fike Corporation 02-3646.

A manual discharge sign at the manual discharge station. Sign shall be Fike Corporation 02-3644.

A flashing light sign over each exit from the protected area. Sign shall be Fike Corporation 02-3645.

2.4.10 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of a universal primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of Master Specification Section 09900, Painting.

2.4.11 Equipment Bases. Unless otherwise indicated or specified, agent cylinders shall be installed on concrete bases at least 6 inches (150 mm) high.

2.4.12 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 CONTROLS.

2.5.01 Control Panel. The clean agent system shall be provided with a single control panel that shall be capable of all functions necessary to operate the system, including detection, actuation, and any auxiliary functions specified herein or otherwise required. The control panel shall be located where indicated on the drawings, and shall be provided with the following:

NEMA 12 enclosure with a hinged and lockable door.

Integral battery standby power supply.

Rechargeable batteries and battery charger.

Audible and visual alarms.

Auxiliary contacts for:

Trouble alarm

System alarm

Pre-discharge alarm

Discharge alarm

Ventilation shutdown

Door closures

0 to 60 second field adjustable time delay.

Container disable switch.

Class A wiring of detection and release circuits.

System inhibit (abort) switch.

Parallel wired agent release modules.

The control panel will be provided with a 120 volt, 60 Hz, single phase power supply.

2.5.02 Detectors. A minimum of two detectors shall be provided in each room. One half of the detectors in the room shall be ionization type, and the remainder shall be of the rate compensation thermal type. The temperature setpoint of thermal type detectors shall be as required, unless otherwise required by application.

2.5.03 Manual Release Switch. The manual release switch shall provide a means to discharge the container, and shall bypass all abort and time delay functions, and shall activate all alarm and shutdown devices the same as if they had been activated automatically. The manual release switch shall be located at the control panel.

2.5.04 Audible and Visual Alarms. Two audible and one visual alarm shall be provided in each protected room. One audible and one visual alarm shall be provided on the exterior of the building at the entrance to each protected room. One audible shall be the horn type, and the other audible alarm shall be the siren type. The visual alarm shall be the strobe type. Alarms located on the exterior of the building shall be suitable for wet locations.

2.5.05 Emergency Break Glass Switch. Each break-glass switch for fire suppression system shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Square D "Type 9001K15", Cutler Hammer 10250T Series, or approved equal, with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

PART 3 - EXECUTION

3.1 INSPECTION. Contractor shall field verify all existing conditions prior to submitting a bid proposal.

3.2 INSTALLATION. The installation of the complete clean agent suppression system shall be performed by the system manufacturer or an approved representative of the manufacturer. The fire suppression system shall be installed by a firm having previously installed a minimum of 5 systems similar in size and scope to this project. Personnel involved in the installation of the suppression system shall be fully experienced in installing fire detection and clean agent suppression systems. The installation of the work described herein shall be performed to avoid interference with the structure and all other equipment, wiring, piping, and ductwork located in the spaces.

Piping, wiring, equipment, and appurtenances furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. The installation shall be in accordance with the NFPA 70, NFPA 72, and NFPA 2001.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

3.2.01 Wiring. The fire suppression system contractor shall be responsible for the wiring of all devices associated with the clean agent suppression system, including but not limited to, detection devices, actuation devices, and audible and visual alarms. A 120 volt single phase power supply to the suppression system control panel will be provided by others. Wiring from the control panel to any automatic door closers will be provided as indicated in the Contract Documents. Wiring from the control panel to any ventilation systems will be provided as indicated in the Contract Documents. Any automatic door closers will as indicated in the Contract Documents. Wiring shall be in accordance with NFPA 70, NFPA 72, and Master Specification Section 16050, Electrical General Requirements.

3.3 CONTROL. The clean agent suppression system shall be capable of completely automatic operation as described herein and as specified by NFPA.

Upon the activation of the first detector, the following shall occur:

An "ALARM" lamp on the control panel shall be illuminated.

An audible alarm (horn) and visual alarm (strobe) shall be energized in the protected room.

The ventilation system shall shut down.

The door closers shall be activated.

Upon the activation of any second detector, the following shall occur:

A "PRE-DISCHARGE" lamp on the control panel shall be illuminated.

An audible alarm (siren) shall be energized in the protected room.

The agent discharge time delay sequence shall be initiated.

Upon completion of the time delay sequence, the following shall occur:

The extinguishing agent shall be released from the cylinder.

A "SYSTEM DISCHARGE" lamp on the control panel shall be energized.

A visual alarm (strobe) on the exterior of the building shall be energized.

3.4 CLEANING. Immediately prior to the final inspection, equipment, piping controls, and appurtenances shall be thoroughly cleaned. Dirt and debris shall be cleaned from discharge nozzles. Nozzles having paint other than factory finish shall be replaced with new nozzles.

3.5 ACCEPTANCE TESTS.

3.5.01 Tests. The fire suppression system shall be tested for correct operation and function. The tests shall be as specified by the local fire department and the following procedures performed in accordance with NFPA 2001:

Review of mechanical components.

Review of enclosure integrity.

Review of electrical components

Functional testing.

The tests shall be supervised by a competent, factory-trained engineer or technician authorized by the manufacturer of the equipment.

3.5.02 Enclosure Integrity Test. When indicated, an enclosure integrity test shall be performed by Contractor to ensure that the required agent concentration can be maintained. Prior to performing the test, the fire suppression system contractor shall inspect the rooms to be protected, and shall advise Owner in writing of any probable areas where excessive leakage from the space may cause the test to fail. The test shall not be performed until Contractor is advised by Owner to proceed. All test instruments shall have been recently calibrated by an independent testing agency. Contractor shall be responsible for providing all materials and labor required to perform the test. The test shall be repeated until a successful test is obtained. In the event that the test fails due to excessive leakage from the space, Owner shall be advised of the areas needing repair, and Contractor will be reimbursed a predetermined sum for repeating the test.

3.5.03 Test Report. A report of test results shall be submitted prior to final inspection and acceptance. Three copies of the report shall be furnished to Engineer and the Fire Department.

3.5.04 Final Drawings. After installation and testing of the fire suppression system, complete drawings, conforming to installation records, including location of discharge nozzles, controls, and wiring diagrams shall be submitted prior to final acceptance.

3.5.05 Final Inspection. A representative of the local fire department and Engineer will make a final inspection of the Work. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that all portions of the fire suppression system functions properly. Contractor shall arrange for the final inspection with the fire department and Engineer.

3.5.06 Final Acceptance. The final acceptance of the fire suppression system as specified shall be made after the completion of the Work resulting from the final inspection and after receipt of a formal letter of acceptance from the local fire department.

Deviations from approved "working drawings" for the suppression system require recalculation and approval by authority with jurisdiction. Written approval shall be obtained from Engineer prior to deviating from approved "working plans."

3.6 OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the suppression system manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

SECTION 15360

CARBON DIOXIDE FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK. Furnish and install a complete engineered, fixed pipe, automatic total flooding low pressure carbon dioxide fire suppression system for each of the areas indicated on the Drawings.

Each system shall be specifically engineered and installed to protect the hazard. The design and engineering shall include a thorough review of the proposed rooms for anticipated air tightness. If anticipated leakage appears unreasonably high, it shall be called to the attention of the Program Manager immediately for possible corrective action.

Each system shall be designed, installed and tested in conformance with current Standards as stipulated in item 1.05 hereinafter and the requirements of local authorities having jurisdiction and Insurance Underwriters.

All piping, and equipment shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping is shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the Drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Subcontractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.2 RELATED WORK.

Division 16, Electrical

1.3 ENGINEERING SERVICES. The Subcontractor shall retain the services of a specialty subcontractor to design and install the CO2 system. The specialty subcontractor shall employ a licensed professional engineer (in the State of Michigan) specializing in the design and installation of CO2 fire suppression systems to perform the work. The engineer shall be licensed at the time the work is done. If the state issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.

All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.4 SUBMITTALS. Submit shop drawings, product data and calculations to the city of Detroit Fire Marshall for approval. Submit proof of approval to the Program Manager.

All submittals shall contain a statement that Section 01080 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual one for each party involved, and shall be included with every submittal and resubmittal.

In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Subcontractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Subcontractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4.01 Shop Drawings. Submit shop drawings under provision of Section 01080.

Submit shop drawings indicating detailed layout of system, locating each component. Include control diagrams, wiring diagrams, and written sequence of operation.

Detailed layout drawings of piping in mechanical rooms and other congested areas shall be provided. Drawings shall show the locations of piping appurtenances, specialties, and all valve banks.

1.4.02 Product Data. Submit product data under provisions of Section 01080.

Submit product data for each piece of equipment comprising the system including storage unit, control valves, control panels, nozzles, manual releases detectors, alarm bells or horns and enunciators.

1.4.03 Calculations. For local application and total flood hazards, submit design calculation derived from computer programs developed specifically for low pressure CO_2 flow calculations. Analysis shall include calculation to verify system terminal pressures, nozzle flow rate, orifice code number, piping pressure loses, component flow data, and pipe sizes considering actual and equivalent lengths of pipe and elevation changes.

1.4.04 Test Reports. Submit test reports indicating successful completion of test to the Program Manager.

1.4.05 Installation Instructions. Submit manufacturer's installation instruction under provisions of section 01080.

1.4.06 Operating and Maintenance Data.

Operating and Maintenance Manual - Submit to the Program Manager as provided in Section 01160, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

Equipment shall be identified with the Owner's Equipment Numbers and Identification as described in the specifications and as shown on the Drawings.

Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual.

Contents - Each volume shall contain the following minimum contents:

Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

Spare Parts List

Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

1.5 REFERENCE STANDARDS.

ANSI/ASME B16.3 – malleable iron threaded fittings Class 300.

ANSI/ASME B16.9 – factory made wrought steel butt welding fittings.

ANSI/ASME B31.1 – power piping.

ANSI/ASME B31.1 – pressure vessels.

ANSI/ASME Section 8 – welding and brazing qualifications.

ANSI/WAS D1.1 – Standard Welding Code.

ANSI/NFPA 12 Carbon Dioxide Extinguishing Systems.

ANSI/NFPA 70 – National Electric Code.

NFPA 72 – National Fire Alarm Code.

ASTM–A53 – pipe, steel, black and hot dipped zinc coated, welded and seamless.

ASTM-A106 – seamless carbon steel pipe for high temperature service.

FM – Factory Mutual Engineering.

NEMA – enclosures for control panels.

IRI – Industrial Risk Insurers.

UL – Underwriters Laboratory.

Codes, Ordinances, Permits and Regulations.

Comply with all the laws, ordinances, codes, rules and regulations of the State or local authorities having jurisdiction over any of the work specified herein, and apply for, and pay for, all necessary permits.

If any part of this Section conflicts with the laws and codes, call it to the Program Manager's attention prior to commencing work. If a conflict exists, follow the more strict code or law as approved by the Program Manager.

All materials and equipment where applicable shall be type listed in current edition of FM approved guide.

Requirements set forth in this Section shall be followed when in excess of the required or minimum regulations.

1.6 QUALITY ASSURANCE. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules

Inspection by the Program Manager or his representative or failure to inspect shall not relieve the Subcontractor of responsibility to provide materials and perform the work in accordance with the documents.

The piping manufacturer shall furnish an affidavit of compliance certifying that all materials used and work performed shall comply with the specified requirements. The Subcontractor shall provide copies of mill test confirming the type of material used in the various components.

The Owner and Program Manager reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Owner and Program Manager shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.

All rotating parts of equipment shall be statically and dynamically balanced at the factory.

1.7 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner or Program Manager by the manufacturer.

All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

Instructions for the servicing and startup of equipment in long term or prolonged storage shall accompany each item.

All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.8 DESIGN CRITERIA. The system shall be designed in accordance with the requirements and recommendations of NFPA standards noted above and shall totally flood the hazard volumes with carbon dioxide. Refer to tables in NFPA 12 for design concentrations or as noted on the fire protection systems schedule. Refer to the architectural drawings to obtain dimensions pertinent to determine the volume of the rooms or spaces to be protected.

The system shall be designed to operate automatically or by manual operation. The release of the agent shall be by an electrical signal from the control panel to the solenoid operated releasing devices.

System design shall provide for fire protection of the local application and/or total flooding type with low pressure CO2 and it covers a purging system utilizing the same low pressure CO2 to suppress or prevent fire. The system shall be fixed installation where equipment is designed and installed to provide fire suppression capability for hazards which most likely be in the form of electric heat buildup that will result in fire or explosion conditions. Total flooding shall be done with a calculated CO2 design concentration, volume of space in abnormal temperatures. All space openings shall be sealed against any air movement. Space shall be tested prior to CO2 activation test. Design, fabrication and installation of system and its components shall be in compliance with requirements and recommendations of ANSI/NFPA-12.

Interface system with plant main security room fire alarm and plant annunciation system. Signals that will be monitored shall consist of:

Any Open Doors (greater than ½ hour) - (Trouble).

Any malfunction in the Detectors/annunciation devices/CO2 local panel/CO2 tank/CO2 pressure system and any of the interposing relays in the building - (Warning).

CO2 ready to discharge after a set time interval (selected by the CO2 vendor) – Alarm).

CO2 activation and Discharge - (Alarm with horn).

Individual alarms shall be included also in the building local panel to provide a warning alarm during a time delay period prior to the automatic discharge of carbon dioxide. Refer to the system design in Part -2.

Refer to the electrical drawings to determine Class I, Divisions I and II, Hazard Classification of each room or space. Provide all system components to comply and be suitable for use with the hazard classification.

1.9 PERFORMANCE REQUIREMENTS.

1.9.01 Activation.

Electric: An alarm condition from any detector or operation of a manual release station (electric) shall start the pre-discharge sequence. At this time the control panel shall activate begin the pre-discharge timer(s), start all audible and visual alarm devices, shutdown exhaust air handling fans, close all dampers, release door holders, shutdown fuel and power to process equipment (if any exist inside the space) and actuate the building fire alarm system. The pre-discharge period shall be of sufficient duration for personnel to evacuate the area. The alarm devices shall continue to operate until the control panel is reset.

Pneumatic: A pneumatic time delay and pneumatic sirens are required for all total flood hazards that are normally occupied. Further, a pneumatic time delay and pneumatic sirens are required for local application systems which serve normally occupied enclosures where the discharge will expose personnel to hazardous concentrations of CO_2. The pneumatic siren(s) shall sound during the evacuation and discharge period.

Mechanical: Each master/selector valve shall be provided with an emergency manual override operator.

1.9.02 Volume. The volume of carbon dioxide for the specified concentrations shall be determined using inside area dimensions. The volume of the room space displaced by the equipment shall not be considered to reduce the requirement of carbon dioxide.

1.9.03 Tank Supervisory Alarms. System control power failure, refrigeration motor power failure and refrigeration alarm power failure shall produce a "trouble" alarm and shall be enunciated at the system control panel.

- and/or -

A refrigeration "high-low" pressure signal shall be activated by a pressure operated switch at the storage tank.

PART 2 - PRODUCTS

2.1 MATERIALS. All materials and equipment shall be new and shall be FM approved or UL listed.

2.2 MANUFACTURERS. Systems shall be as designed and manufactured by:

Kidde Fenwal Inc.

The Ansul Co.

Fire Systems Division of Chemetron Corp.

2.3 SYSTEM COMPONENTS.

2.3.01 Pipe and Piping Specifications. The following specifications set forth minimum standards for installation. If the requirements of local codes or the authority having jurisdiction are more stringent these more stringent requirement shall govern the installation.

2.3.02 Type of pipe.

Piping shall be black or galvanized ASTM grade A53 seamless or Electric welded grade A or B or A106 grade A, B or C.

Installation shall be performed in workmanlike manner according to the highest standards of modern practice.

All pipe and fittings shall be new and of recent manufacture.

All pipes shall be reamed after cutting so that all burrs and sharp edges are removed.

All pipes must be thoroughly cleaned before installation. A wire flue brush should be pulled through the length several times followed by clean cloth rags treated for the purpose. All foreign matter and oil must be removed by this process.

All pipes and fittings installed out of doors or in corrosive areas must be galvanized or treated with a proper protective coating.

Pipe Dope: All screwed pipe shall be coated with Teflon tape or an approved pipe joint compound. When tape or pipe joint compound is used coating of the threads must start at least two threads back from the pipe end.

Welding:

All welding must be performed by a certified welder.

All welded pipe 3/4" and smaller shall be welded using a gas welding or other approved method.

All welds shall be pounded to loosen scale and weld beads and then cleaned of the same.

No backing ring chill rings are permitted.

Welded Pipe Reductions: Reductions in welded pipe shall be by one of the following devices.

Butt weld concentric reducers.

Swaged nipples.

Weld o-lets

Where socket weld fittings are permitted see below, a socket weld reducing coupling can be used only for a one size reduction. All other reductions in socket weld pipe shall be made using the above permitted methods.

When methods B, C, or D are used, it is imperative that these fittings be installed in strict accordance with the manufacturer's installation instructions, in each case they must be installed so as to permit full flow. All entrance holes from the main pipe run to the fitting must be of proper size and free of sharp edges, ridges or burrs.

Threaded Pipe Reductions: Reduction in screwed pipe shall be by means of screwed concentric reducing fittings or swaged nipples. Flush bushings shall not be used. Hex bushings, 3000 lb. forged steel may be used for reduction in one pipe size only.

Flanges and Unions:

No unions over 2" size are permitted.

All flanges must be 300 pounds. ANSI class forged steel.

All weld neck flanges used with schedule 80 pipe must have extra heavy pipe wall bore schedule 80. All weld neck flanges used with schedule 40 pipe must have standard weight pipe wall bore schedule 40.

Where flanged pipe connections are used, they shall be gasketed with 1/16" thick compressed type gasket materials.

High grade steel bolts grade 8 or studs with graded nuts shall be used on all flanged connections. All nuts shall have full engagement on the bolt or stud. Use grade 8 or better.

All connectors, that is, bolts, and nuts shall be torqued to the required number or foot pounds as recommended in the standard piping handbooks. Required torque valves for installation of flanged pressure operated valves shall be the same as the Preferred CO2 Systems installed for the Chlor/Dechlor building of the GLWA WRRF.

Pipe take-Offs: All pipe take offs shall be from the side or bottom of the header. Where a take off involves a reduction of several pipe sizes, a bottom take off should be provided.

2.3.03 Tank Header. The tank header is under continuous pressure and therefore it shall be constructed of schedule 80 black steel pipe with extra heavy welding fittings and ANSI 300 pound class flanges.

The tank header can be fabricated using one of the following procedures or by a combination of these procedures.

By the use of extra heavy butt welding fittings.

By the use of extra heavy weld o-lets or thread-o-lets or equivalent.

All welds must allow full flow. No miter weld fittings shall be used. Backing rings, chill rings shall not be used.

2.3.04 Actuation Line. All piping shall be either1/2", threaded steel pipe or stainless steel tubing.

When pipe is used, the following applies:

The pipe shall be a minimum of schedule 40 and where it is installed outdoors or other corrosive environments, galvanized pipe shall be used. (Industrial Risk Insurers requires all piping to be schedule 40 galvanized or schedule 80 black.)

All threaded pipe connections shall be treated with a suitable pipe sealant (i.e., Swak by Cajun Part No. MS PTS-50: Rector seal or equivalent is acceptable). The use of Teflon tape on actuation line piping is not allowed.

All pipe fittings shall be 300 lb. malleable or ductile iron. A 300 lb. steel union shall be installed near the termination of all piping. The use of 150 lb. fittings is not allowed.

Whenever tubing is used, the following applies:

All steel tubing shall be 1/2" X .035 wall and shall be painted to provide corrosion protection. All tubing installed outdoors or in corrosive atmosphere shall be stainless steel 1/2" X .035.

All tubing fittings shall be of the same material as the tubing and shall be of the compression type. All tubing to pipe fittings shall be treated with a pipe sealant as described in 2.B above.

All tubing shall be properly supported.

A filter supplied by CO2 equipment supplier shall be installed at the actuation line termination into each valve, (as shown on design drawings).

Whenever a hose reel bleeder valve is used, a 1/4" pressure regulator may be installed directly on top of the sub-header piping upstream of the selector valve or bleeder. The location of these regulators shall be as shown on the system design drawings.

The actuation line shall be provided with an approved pressure regulator to maintain 100 PSI pressure on the actuation line.

The actuation line shall be provided with an approved two level supervisory switch to provide notification at the control panel when pressure in the actuation line drops to 90 PSI and 80 PSI respectively.

2.3.05 Master Valve Piping. All piping downstream of master valve between master valve and selector valves or between valve and hose reels shall be either

Schedule 40 black steel pipe welded with welded fittings, or,

Schedule 40 steel pipe with listed grooved type couplings and fittings.

When method (A) is used, the following can be used.

Standard weight socket weld fittings are acceptable with exception that no reducing coupling can be used only for a one size reduction. All other reductions shall be made using a butt welding concentric reducer.

Standard weight butt-welding fittings. Backing rings, (chill rings) shall not be used.

1000 pound forged steel screwed fittings, back welded.

When method (B) is used, the following applies:

Where grooved couplings and fittings are used, they shall be listed/approved for use with low pressure carbon dioxide fire systems.

Pipe preparation must be in strict accordance with the manufacturers recommended procedure. Installation must be exactly as per the manufacturing specifications in all aspects.

Grooved couplings shall be installed so as the allow contraction of the pipe (pipe ends butted together).

Grooved couplings must be approved in advance by the system designer with approval obtained prior to start of design.

2.3.06 Discharge Piping. Piping downstream of selector valves, that is piping which is open to atmosphere, shall be schedule 40. Screwed pipe joints are always permitted and in most installations, approved grooved pipe connections may be used. Grooved fittings must be approved for use with carbon dioxide. Approval of fittings must be sought prior to the start of installation.

Screwed Joints: Threaded pipe fittings shall be class 300 pound malleable iron or ductile iron for pipe through 3" 1000 pound ductile iron forged steel shall be used in all larger sizes.

Grooved Joints:

Where grooved couplings and fittings are used, they shall be listed/approved for use with low pressure carbon dioxide fire systems.

Pipe preparation must be in strict accordance with the manufacturer's recommended procedure. Installation must be exactly as per the manufacturer's specification in all respects.

Grooved couplings shall be installed so as to allow contraction of the pipe (pipe ends butted together).

2.3.07 Pressure Relief Piping and Fittings. Piping to pressure reliefs shall be as specified above for discharge piping. All takeoffs for pressure relief piping shall be from the top of the discharge piping.

2.3.08 Dirt Trap. A dirt trap consisting of a tee with capped nipple shall be installed at the end of each run. The nipple shall be at least 2" long. A longer nipple up to approximately 18" is preferred where space permits.

Note: Dirt traps for schedule 40 welded headers are to be formed by welding a schedule 80 nipple to the end of the line. The schedule 80 nipple is threaded at the open end for connection of a screwed pipe cap.

2.3.09 Underground Piping. Underground piping is to be avoided - if unavoidable, a piping configuration layout for underground piping should be submitted, a layout for underground piping should be submitted for approval to system designer prior to the start of system design. The following general requirements shall apply to underground piping:

Trench depth for underground piping shall be a minimum of 3 feet or below frost line whichever is deeper.

Underground pipe shall be schedule 80 black steel with welded joints as specified for the type of run involved.

A protective, insulate covering will be required of all underground pipe. Approval of system designer is required.

Underground piping shall be welded when possible. The only exception would be in a hazardous location where welding is not permitted. In this case, flanged connection shall be used. All underground pipe joints shall be tested for leaks at 300 PSI before the insulation and protective coating is applied.

2.3.10 Pipe Sleeves. All piping through building walls, partitions, floors slabs, roof slabs and the like, shall be sleeved.

Sleeves shall be schedule 40 pipe at least two sizes larger that the pipe being sleeved. One inch pipe is the minimum size to be used as a sleeve.

Sleeves shall be packed with an approved sealing material so as to be dust light.

Sleeves through floor slabs must extend at least 2 above the floor. A greater extension may be used if required by local building codes.

Sleeves extending through roof slabs must extend above the roof and be flashed in accordance with local building codes.

2.3.11 Expansion Joints. Contraction of steel piping during discharge is based on 1" of contraction per 100 feet of steel pipe.

Allowance must be made for this contraction by using either a joint which permits movement, a piping system which contains natural swing joints, fabricated circular type "U" type bends or, in cases where space is limited, an approved manufactured expansion joint.

In piping which utilized grooved type couplings, these couplings shall be installed to permit contraction of the piping.

In straight runs using welded or screwed joints, an expansion joint must be installed within approximately 100 feet of continuous run and each approximate 100 feet of run thereafter. For runs using grooved pipe, a representative of the manufacturer should be contacted to determine the location and number of expansion joints in long runs.

Pipe anchors shall be capable of with standing any contraction thrusts that may be imposed by the piping while permitting movement intended in the design of the piping system to relieve stress. This will required rigid anchoring of certain points in the piping system while leaving other points of the pipe free to move longitudinally so as to relieve stress.

2.3.12 Inspection for Mechanical Integrity. All testing and inspections shall be done in the presence and under the supervision of the equipment manufacturer's test representative.

All pipe and fittings that are under constant tank pressure ball shall be bubble tight. Bubble tests shall be made using leak-tec, or approved equal, under full tank pressure.

Concealed pipe joints such as those in walls, ceilings, trenches and the like shall be tested at 300 PSI before the joint is concealed.

Pipelines not under constant pressure shall not exhibit any visible or audible leak, but bubble tightness is generally not required.

Under no conditions shall water be used to test piping or other CO2 equipment. Either dry nitrogen or CO2 shall be used for testing.

2.3.13 Painting. nPainting requirements shall be similar to the painting used for the Chlorination/De-chlorination buildings of GLWA WRRF and shall be of the moisture resistant/proof type and suitable for indoor and outdoor use.

2.3.14 Pipe Hangers and Supports. All pipe hangers and supports shall conform to the provisions outlined in ANSI B31.1, latest edition, except as modified and supplemented by this specification. All pipes must be solidly anchored to structural members where longitudinal or lateral movement is possible.

Rigid hangers are required wherever a change of direction or a change in the elevation of the piping system occurs. For long straight runs and as a minimum, every other hanger shall be rigid. All hangers shall be fabricated of steel and installed in a workmanlike manner.

All piping shall be attached to rigid hangers by means of u-bolts locked double nuts. The pipe shall be free to move longitudinally within the u-bolt except where the piping design requires it to be anchored.

Hangers and pipe shall be designed to prevent stress from being induced into piping during the temperature change caused by a system discharge.

All piping supports shall be fabricated and installed so that they will not be disengaged by the movement of supported pipe

Pipe shall not be hung using one pipeline as a support for another.

Piping supports shall be arranged so that no excessive bending stresses are induced into the piping from concentrated loads between supports.

The maximum spacing between pipe supports for screwed or welded pipes is given in table 1 below:

Table #1
Maximum Spacing between Supports for Screwed or Welding Pipe:

Nominal Pipe Size (Inches)	Maximum Span (Feet)
1/4	5
1/2	5
3/4	6
1	7
1 1/4	8
1 1/2	9
2	10
2 1/2	11
3	12
4	14
5	16
6	17
8	19

Maximum spacing between pipe supports is given in table 2 below for systems utilizing the grooved coupling method for system discharge piping.

Table #2
Minimum Spacing between Supports for Pipe with Grooved Joints:

Nominal Pipe Size (Inches)	Maximum Span (Feet)
3/4	7
1	7
1 1/4	7
2	7
3	10
4	10
5	12
6	12

2.4 Carbon Dioxide System Component Requirements. The components of the carbon dioxide systems shall be provided in accordance with the following requirements.

2.4.01 Storage Unit. The storage tank shall be built to ASME standards, and bear the ASME label. It shall be installed for all the electrical buildings specified under item 1.01A with flexible hoses to the CO2 piping system to provide flexibility of movement and protect for any unexpected differential settlement of the concrete pad which may exceed 1.5”. The installation of such hoses shall meet the requirements of NFPA 12.

The storage tank is to have a baked white aluminum housing to protect the insulation and should be riveted and sealed at all joints, to prevent water damage to the insulation.

The storage tank shall be supported by two saddles of heavy steel construction welded and cross braced to the vessel for adequate support.

The storage vessel shall be provided with two top lifting lugs.

Tank pressure gauge shall be 6 inch dial type with a rated accuracy of 1/2 of 1%.

The tank liquid level gauge shall read contents in thousand of pounds of liquid CO2 at 0 degrees Fahrenheit. The gauge divisions shall be in two hundred pound increments.

The liquid level gauge shall be equipped with one set of electrical contacts which may be used to enunciate a low liquid level in the storage unit.

The storage unit shall be equipped with two independent alarm pressure switches for annunciation of high or low tank pressure. These switches shall operate at 315

PSIG and 250 PSIG respectively.

The storage unit shall be equipped with the required ASME safety relief. This relief shall be set at 350 PSIG.

A high pressure bleeder valve set at 330 PSIG shall be included with the storage unit assembly.

•The refrigeration system shall operate on a power supply of 208 or 460 volts, 60Hz. For the power service to the refrigeration system, a disconnect switch shall be provided by the CO2 vendor and shall be installed by the electrical contractor.

2.4.02 Valves. All valves shall meet the requirements set forth in the current edition of the NFPA Standard 12, and shall be F.M. approved for carbon dioxide extinguishing systems.

Tank Shut-Off Valves

A manually operated tank shut-off valve shall be provided. Valves are sized 3" through 8" and shall be equipped with a geared hand wheel operator and carry a 300 pound rating. The flanges mounted either side of the valve must have inside diameter chamfered 1/4" deep 45 degree angle for the valve clearance.

The tank shut-off valve shall be equipped with a DPDT limit switch to permit remote annunciation if the valve is other than fully opened. The contacts shall be provided on the tank shut-off valve to indicate fully closed position.

Master/Selector Valves

Valves in sizes 1/2" to and including 2" shall be ball type approved for low pressure carbon dioxide service. Valves in sizes 3" and larger shall be high performance butterfly style suitable for low pressure carbon dioxide service.

The master valve and selector valve shall not fail open. The master or selector valve shall not open automatically in the event of any electric or pneumatic failure.

Master/selector valves shall be provided with spring return pneumatic actuators. An override device shall be mounted on the valve actuator or within the Automatic Time Delay Cabinet for emergency manual operation.

Isolation Valves

Valves in sizes 1/2" to and including 2" shall be ball type approved for low pressure carbon dioxide service. Valves in sizes 3" and larger shall be high performance butterfly style suitable for low pressure carbon dioxide service.

The isolation valve shall be fitted with an electrical status switch.

The isolation valve shall have device to accommodate a lock.

2.4.03 Actuation Line Supervision. Actuation line serving all master/selector valves shall be supervised.

Actuation line to be provided with a supervisory pressure switch to provide annunciation at 80 PSI.

Actuation line to be provided with a pressure regulator to maintain 100 PSI on the line.

2.4.04 Nozzles. Nozzles shall be supplied in quantities sufficient to properly cover the areas being protected in accordance with NFPA-12.

Nozzles shall be permanently marked as to type and orifice.

2.4.05 Electrical. The electric service to the storage tank shall be provided with a fused disconnect supplied by the CO2 vendor and sized per the electrical requirements of the tank compressor.

CO2 System Control Panel and electrical devices shall be designed to operate on 24 VDC service.

All field electrical devices shall be supervised for electrical integrity.

All master/selector valve solenoid circuits shall incorporate maintenance lock-out switch to disable the solenoid during maintenance.

2.4.06 Control Panel. Provide an AUTOPULSE IQ-636X control panel or equivalent and to be located as shown on the drawings to electrically activate the carbon dioxide system. The control panel shall be modular and serve as many zones as required.

The control panel shall be FM approved for fire alarm and releasing service.

The control panel shall provide visual indication on the panel face for the following:

Each initiating circuit alarm and circuit trouble.

Each carbon dioxide release circuit alarm and circuit trouble.

Primary power source failure for each zone.

The control panel shall operate on the single zone concept. Any single activated detector shall be processed by the control panel as an alarm condition. The discharge circuit shall be energized in the affected area and the red "Release" LED on the panel will illuminate.

Alarm, trouble and AC power failure output contacts for each zone shall actuate the local alarm and common building fire alarm system.

Provide SPDT dry contacts for the following output signals to the Building Fire alarm panel:

General alarm condition, discharge notification.

General trouble condition, operational problem notification.

Loss of primary power source to the control panel.

Discharge disabled mechanically or electrically.

Storage unit refrigeration unit power failure.

Storage tank "high-low" pressure trouble.

The control panel shall have battery backup to support the entire system for 24 hours and then perform an alarm sequence for 10 minutes in the event of a primary power failure, but in no case shall be less than 8 AH. A charger shall be provided to recover the batteries in 48 hours from a fully discharged condition. Standby batteries shall be of the sealed, gel-type or lead calcium type. Batteries shall be supervised and provided a trouble signal upon low voltage, open or shorted cell.

The control panel shall be UL listed, FM approved and comply with the requirements as set forth in NFPA 72.

The control panel shall have Class “B” parallel wiring of the all the detection circuits.

The control panel shall utilize series supervised solenoid devices as the method of discharging the extinguishing agent. The solenoids shall be energized directly from the control panel when system discharge is required. Systems which employ devices external to the control panel to either supervise releasing devices or provide energy for discharge will not be accepted.

The control panel shall be equipped with a supervised service disconnect switch. Operation of this switch shall generate a trouble signal, activate a LED and electrically isolate all releasing devices from receiving a discharge signal. With the switch in the "disconnected" position, it shall be possible to simulate any alarm condition and observe proper operation of all detection and signaling circuits without causing agent discharge.

The control panel shall be equipped with auxiliary relays for shutdown operations. The control panel shall be capable of programming relays independently to operate on either, trouble, alarm, pre discharge, or discharge modes.

The control panel, in addition to its yellow system trouble LED, shall further break down a trouble condition with the use of diagnostic LED's. These LED's shall indicate the following trouble conditions:

Open condition, pressure supervisory circuit (separate diagnostic LED).

Alarm audible circuit reverse polarity, open or short circuit.

Pre discharge/discharge audible circuit reverse polarity, short or open.

Detection circuit (separate LED for each detection circuit).

Releasing circuit open circuit.

Manual release circuit open circuit.

AC power loss.

Ground fault.

System alarm audible circuit reverse polarity, short or open.

Microprocessor failure flashing indicator.

The control panel shall have a common control board, which provides common alarm and trouble indications as well as alarm silence and reset switches. A common Class "B" wired general alarm circuit shall be provided for common area signaling as well as separate form "C" dry contacts for general alarm and trouble. A signal switch shall be provided that will silence all active signals. Silencing of audible alarms shall be controlled by "resound" logic, whereby any subsequent new alarm conditions will reactivate audible circuits. A "lamp test" switch shall be provided which will illuminate all alarm and diagnostic LED's.

Control panel shall have a solid state, high speed switching power supply with 24 VDC output capable of responding instantly to voltage and current surges on the input and output sides to protect the system from malfunction and damage. A supervised battery charging circuit and ground fault sensing circuitry shall be an integral part of the power supply. Battery standby power shall be "on line" such that batteries will supply power to the system in the event of AC power loss without a power transfer relay.

One board shall be provided for each protected area. The unit shall provide Class "A" wired detection and series supervised release circuits, Class "B", different distinct audible and visual indications for alarm, pre- discharge, and discharge conditions. Supervised manual release circuits shall be provided.

Each control panel shall have alarm output contacts (dry) for "system operation" and "system trouble," that shall:

> Be direct hard wired into the HVAC control systems serving the building ventilation shut them down in the event of an alarm.
>
> Be connected to the plant process control system to alert the operators of a problem.
>
> See paragraph 3.03B below.

2.4.07 Alarm Devices. Electrically actuated fire alarm horns and strobe lights shall be furnished and installed. Each fire alarm horn strobe shall be actuated and receive operating power from the control panel. Terminals for this purpose shall be provided in the system control cabinet. Each device shall be approved or listed.

The contractor shall furnish and install adequate fire alarm horns and strobes (orange color) to notify plant personnel located in the protected areas. Additionally, horn/strobes shall be provided outside the entrance(s) to the protected area. The output for the audible and visible devices shall be adequate for the conditions encountered.

2.4.08 Thermal Detectors. Compact, stainless steel cover, hermetically sealed assembly, rate of rise compensating type. The setting shall be in accordance with NFPA 72E recommendations.

2.4.09 Manual Release Stations. The Manual release stations shall be located at major points of egress and as shown on Drawings. The manual release station shall provide a means of manually discharging the automatic fire extinguishing system when used in conjunction with the control panel. The manual release switch shall be the "dual action" type, to prevent accidental operation. The switch shall remain in the operated position until reset.

2.4.10 Tank Final Inspection and Test. After all live testing is done on an area or an electrical room, the tank/s shall be recharged when done at the contractor's/vendor's expense before sign off.

2.5 SYSTEM DESIGN TOTAL FLOODING SYSTEMS. Design of the carbon dioxide system shall be based upon the enclosure being sufficiently tight against agent leakage with all ventilation automatically shut down and/or fire dampers to provide for static air condition upon discharge, or shall be appropriately designed to compensate for openings that cannot be closed. Refer to Paragraph 1.01B above.

All appropriate doors, windows, vents and dampers shall be automatically closed before discharge of carbon dioxide. Devices for this purpose shall include pressure operated trips or switches where appropriate.

Agent quantity calculations shall be determined from dimensions furnished on contract drawings for a design concentration percentage at a minimum anticipated hazard temperature.

Pre discharge alarms and mechanical discharge delays shall be provided. They shall be of sufficient duration to warn personnel of an impending discharge of carbon dioxide and allow for hazard area evacuation and preparation.

Electronic Time (discharge) delays will not be permitted or acceptable.

Warning signs shall be provided at each entrance doors to the buildings. The warning signs shall be 18" high by 30" wide with a baked enamel finish. Lettering shall warn the personnel of the presence of a CO2 fire suppression system.

The minimum discharge period shall be within 1 minute. The discharge period shall be lengthened as appropriate by considerations such as deep seated type fires.

Discharge nozzles, detectors and auxiliary equipment shall be located so as not to interfere with the hazard operation and/or maintenance.

PART 3 - EXECUTION

3.1 INSTALLATION. The Subcontractor shall not install any equipment or materials until the Program Manager and DESIGN SUBCONSULTANT had approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Subcontractor's risk.

Provide all labor and material required to set up, mount and connect all system equipment in accordance with NFPA standards. The system shall be installed in strict accordance with the manufacturer's recommendations.

All piping and fittings shall be thoroughly cleaned as assembled. All welded joints to be pounded to loosen scale and weld beads and then use the following procedure. Pull wire flue brush through each length several times. Pull clean cloth rags (not burlap or similar) treated with carbon tetrachloride, or a solution of 50 percent carbon tetrachloride and 50 percent Stoddard's solvent through each pipe length.

The system shall be wired in accordance with the manufacturers diagrams and requirements and the regulations of the Detroit Fire Department. All wiring shall be installed in conduit.

All wiring shall be in accordance with the NEC and local codes, the NFPA Standards No. 72, 72E, 72G, 72H, or the local authority having jurisdiction.

The Subcontractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

3.2 INSTRUCTIONS. The system shall include permanent nameplates and instruction plates to identify the system and instruct its use under emergency conditions. In addition, provide three copies of an operation and maintenance manual which shall include system mechanical and electrical drawings, a written description of the system design and operation referenced to the system drawings, technical bulletins describing each piece of equipment in the system and inspection and maintenance directions.

3.3 SEQUENCE OF OPERATION. The system shall be designed and installed such that it is actuated by any one of the detectors located in the substation rooms.

Actuation of any detector or manual station shall:

Provide steady alarm electronic sounder signal associated with the area in which the detector was actuated.

Annunciate to Owner's monitoring equipment at the plant central security room.

Perform necessary control functions such as HVAC equipment shutdown and dampers closure.

Shut down and/or keep all emergency generators from starting.

Close all doors leading into protected area.

Discharge agent.

The system shall be capable of being actuated by manual discharge switches for each protected area. Operation of a manual discharge switch shall cause alarm and shutdown devices to operate the same as if the system had operated automatically and shall cause immediate discharge after the time delay period.

Upon entering the alarm mode, audible indication shall be supplied by the steady sounding of an alarm electronic sounder. This unit shall be polarized for full supervision and UL listed. It shall have an output of 82 to 99 dBA at 24 VDC. The sounder shall be provided with a red finish. All field wiring connections shall be made to terminal strips or wire leads on the device.

3.4 ACCEPTANCE TESTS. Perform a complete approval test in the presence of the Owner's representative and governing authorities.

All test procedures shall be performed in accordance with NFPA 12, Section 1 7.3.

Tests shall demonstrate that the entire system functions as intended. All circuits shall be tested: Automatic discharge, manual discharge equipment shutdown and alarm devices. In addition, supervision of each circuit shall be tested. Each detection device shall be tested according to the manufacturer's recommended procedures and NFPA 72E.

Discharge tests shall be conducted. Tests shall be conducted with the equipment manufacturer or equipment manufacturer's representative in the presence of the Owner's representative. Such tests shall be made only after the control system has tested satisfactorily. Carbon dioxide shall be used as the test agent.

Test containers shall be filled to the designed weight. The amount of gas shall be certified by the Subcontractor.

Provide all necessary test apparatus and instrumentation including gas to be expended.

Gas analyzers capable of automatically monitoring three sampling points simultaneously shall be provided. Concentration measurements shall be recorded every 5 seconds on separate strip charts. Sampling probes shall be placed at three different heights in different sections of the protected area. In no case will a probe be placed higher than the highest anticipated combustible hazard. In large buildings, additional test points may be required. The number of points shall be determined by the Program Manager.

Correct all defects and make additional tests, at no additional cost to the Program Manager or Owner, until the system complies with all contract requirements.
Upon acceptance by the Program Manager and the authority having jurisdiction, the complete system shall be reconditioned, tanks refilled and the system placed in full

operation with proper tags.

As a condition of final acceptance, provide operational training to the Owner's personnel. The training sessions shall include emergency procedures, system control panel operation, trouble procedures and safety requirements. Refer to item 4.03 below.

A maintenance agreement shall be submitted to the Owner for consideration only.

As part of the acceptance test, the contractor shall prepare and submit all the ‘As-built” drawings, and tables to the Program Manager.

PART 4 - SPECIAL REQUIREMENTS

4.1 FACTORY TESTING AND WITNESSING. Factory testing is required on the individual devices and equipment of the complete CO2 system and as specified under this specification. All factory testing documentation and written reports shall be properly dated and made available to the owner representative on site.

At least 2 weeks before the proposed field testing for acceptance of the complete CO2 system, contractor shall notify the engineer of the expected testing date for witnessing. The contractor shall submit a report from the CO2 vendor and equipment manufacturer detailing the proposed performance testing of the system.

4.2 SPARE PARTS AND MAINTENANCE TOOLS. Spare parts, maintenance and tools shall conform to the requirements of specification Section 01180. The CO2 vendor can submit a recommended spare parts list for all equipment supplied to allow DWSD decide and select from the list and also allow the plant to enlarge list if is found necessary to do that.

4.3 TRAINING. The CO2 vendor shall provide a training program to the owner. The program shall include all timing, materials, classes and any required certification for the plant personnel to assume responsibility of maintaining the CO2 system with the help of CO2 specialists.

The CO2 contractor shall present to the owner a document outlining the procedure to incorporate the training indicated in (A) above.

4.4 WARRANTIES. The products shall be warranted against any defects in material or workmanship per Section 01180.

The manufacturer of the equipment shall describe the maintenance to be performed during the warranty period to maintain warranty conditions.
In addition to the above, the following special warranty provisions shall apply:

The Subcontractor shall obtain an extended warranty for 3 years for the equipment furnished under this specification.

The extended warranty shall cover all equipment furnished under this specification from the time it is placed into operation (which can be any time during the construction period) until one year after final acceptance.

The extended warranty can be in the form of:

A maintenance agreement that should be included in this contract shall cover any equipment installations/replacements, repair, recharging system, corrective and preventive maintenance, calibration of gauges and monitoring devices (if any installed in the system) and inspection and testing. In addition to that, the agreement shall allow DWSD to get specs, PMs, and equipment info into their CMMS and get DWSD personnel trained to all of that. In addition to above, the agreement can include an O&M contract in place with the right training, certifications, and licensing to do all of this as recommended by the CO_2 supplier.

End of Section

SECTION 15400

PLUMBING

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated in the Contract Documents. Additional requirements for plumbing systems shall be as indicated in the schedules on the drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as specified in the schedules. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All plumbing equipment, piping, and valves denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Metal nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-

1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Plumbing equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080 Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Horsepower (kW).

Power requirements.

Net weight.

Wiring diagrams.

Plumbing Fixtures

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Water consumption data.

Overall dimensions.

Rough-in dimensions.

Piping connection sizes and locations.

Net weight.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated in the Contract Documents.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Qualification. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

1.5.03 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5.04 Construction. Plumbing fixtures shall be constructed in accordance with the following standards:

Enameled Cast Iron	ANSI/ASME A112.19.1M
Vitreous China	ANSI/ASME A112.19.2M
Stainless Steel	ANSI/ASME A112.19.3M

Enameled Steel	ANSI/ASME A112.19.4M
Emergency/Safety Fixtures	ANSI Z358.1

Electric water coolers shall be UL listed and certified in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 1010. All materials in contact with water shall comply with the Safe Drinking Water Act of 1986, and the Lead Contamination Control Act of 1988.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.7 EXTRA MATERIALS. Extra materials shall be furnished for each type and size of plumbing fixture or equipment as indicated in the Contract Documents, in the quantities indicated below.

Part	Number Required
Flushometer valve repair kits	1 per 5 fixtures
Tank type water closet ballcocks, flush valves, and floats	1 per 5 fixtures
Water closet seats	1 per 10 fixtures
Faucet washer and O-ring kits	1 per 5 fixtures
Faucet cartridge and O-ring kits	1 per 5 fixtures
Electric water heater elements	1 per heater
Water heater relief valves	1 per heater

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the drawings.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated on the drawings.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

2.4.02 Surface Preparation. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.03 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of Master Specification Section 09900, Painting.

2.4.04 Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.05 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.06 Piping Systems. Unless otherwise specified herein, piping system materials shall conform to Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies and Master Specification Section 15061, Ductile Iron Pipe.

2.4.07 Valves. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall conform to the Master Specification Section 15100, Miscellaneous Valves and Master Specification Section 15104, Resilient-Seated Gate Valves.

2.5 WATER SUPPLY PIPING ACCESSORIES.

2.5.01 Water Hammer Arrestors. Water hammer arrestors shall be either bellows or piston type. Bellows type arrestors shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arrestors shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arrestors shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arrestors shall be rated for a maximum working pressure of 350 psig (2400 kPa gauge) and a temperature range of 33° F to 250° F (1° C to 120° C). Water hammer arrestors shall be Smith "Hydrotrol", Josam "75000 Series Absorbotron", Wade "Shokstop", Sioux Chief "Hydra-Rester", or approved equal.

2.5.02 Trap Primers. Trap primer valves shall be flow activated, pressure activated, or tailpiece type as indicated in the Contract Documents.

2.5.02.01 Flow Activated Trap Primers. Flow activated trap primer valves shall be the automatic type activated by water flow in a pipeline. The primer valve shall consist of a bronze body with removable operating parts, an integral vacuum breaker, and a gasketed access cover. Connections shall be 1/2 inch (13 mm) NPT. Trap primer valves shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1018. Trap primer valves shall be Smith "2699", Josam "Series 88250", Wade "W-2400", or approved equal.

2.5.02.02 Pressure Activated Trap Primers. Pressure activated trap primer valves shall be the automatic type activated by pressure drop in a pipeline. The primer valve shall consist of a brass body with removable operating parts and an integral air gap. A distribution unit shall be provided when a single primer valve serves multiple traps. The trap primer shall be self-adjusting to line pressure and shall not require field adjustment. Connections shall be 1/2 inch (13 mm) NPT. Trap primer valves shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1018. Trap primer valves shall be Precision Plumbing Products "Prime-Rite PR-500", or approved equal.

2.5.02.03 Tailpiece Trap Primers. Trap primers installed in a flush valve water closet supply or lavatory drain shall consist of a chrome plated brass plumbing fixture tailpiece with a 1/2 inch (13 mm) OD diverter pipe and compression connection for copper tubing.

2.5.02.04 Thermostatic Mixing Valves. Thermostatic mixing valves shall comply with ASSE 1017, shall be bronze or brass body, with stainless steel flow control components, threaded end connections, rotating handle adjustment, lockable setpoint, and hot and cold check stops. Valves shall be suitable for flow ranges and have temperature adjustment ranges as indicated in the schedules. Accuracy shall within 3° F (2° C) of setpoint. Thermostatic mixing valves shall be manufactured by Symmons, Leonard, Powers, or approved equal.

2.6 DRAINAGE AND VENT PIPING ACCESSORIES.

2.6.01 Cleanouts. Cleanouts shall be provided where indicated on the drawings and required by the referenced codes.

Floor cleanouts shall consist of a two piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanouts shall be stainless steel or nickel bronze, as indicated. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.

Cast iron cleanouts shall be manufactured by Smith, Josam, Wade, or approved equal. Polypropylene cleanouts shall be manufactured by Orion, Enfield, or approved equal. PVC cleanouts shall be manufactured by Sioux Chief, or approved equal.

2.6.02 Bell-Up Drains. Unless otherwise indicated, bell-up drains shall consist of a drainage pipe hub extended to 1 inch (25 mm) above the finished floor. For chemical-resistant waste systems, bell-up drains shall consist of a plain end section of pipe, with a coupling extended 1 inch (25 mm) above the finished floor.

2.6.03 Funnel Receptors. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch (25 mm) above the finished floor.

Funnel receptors shall be Smith “Series 3800”, Josam, Wade, or approved equal.

2.6.04 Floor Drains. Floor drains shall be of the types specified herein and indicated on the drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.

Cast-iron floor drains shall be manufactured by Smith, Josam, Wade, or approved equal. Polypropylene floor drains shall be manufactured by Orion, Enfield, or approved equal. PVC loor drains shall be manufactured by Sioux Chief, or approved equal.

2.6.05 Roof Drains and Overflow Roof Drains. Roof drains and overflow roof drains shall be of the types specified herein and indicated on the drawings. Roof drains shall consist of a cast iron dome, a cast iron body, a sump receiver, an integral flange, and an extension for insulation thickness, where applicable. Drains for aggregate-surfaced roofing shall be provided with gravel stops. For other than cast-in-place locations, roof drains shall be provided with underdeck clamps. When indicated on the drawings, overflow roof drains shall be provided with interior extension rings. Roof drains and overflow roof drains shall be manufactured by Smith, Josam, Wade, or approved equal.

2.6.06 Downspout Nozzles. Downspout nozzles shall be cast brass or bronze, and shall be provided with a threaded inlet and a mounting flange. The mounting flange shall be provided with drilled fastening lugs. Downspout nozzles shall be Smith

"Model 1770", Josam, Wade, or approved equal.

2.6.07 Modular Trench Drain System. Modular trench drain systems shall be of the types specified herein and indicated on the drawings. The modular trench drain system shall include pre-sloped channel drain sections, end caps, outlet connections, grating, and all other components and accessories required for a complete installation. Drainage channels and related components shall be constructed of corrosion resistant polymer concrete. The grating shall be suitable for extra heavy traffic. The modular trench drain system shall be manufactured by Smith ACO, ABT Polydrain, or approved equal.

2.6.08 Floor Sinks. Floor sinks shall consist of a cast iron body with acid resistant interior finish, and a nickel-bronze grate. The grate shall be of the type indicated on the drawings shall be easily removable for cleaning. Floor sink grates and outlets shall be sized as indicated on the drawings. Floor sinks shall be manufactured by Smith, Josam, Wade, or approved equal.

2.6.09 Backwater Valves. Backwater valves shall be of the types as specified herein and indicated on the drawings. In-line backwater valves shall be provided with a hinged flapper valve and a bolted top access cover or a knife gate valve as indicated on the drawings. Knife gate valves shall be provided with a bronze gate and removable wheel handle. When indicated on the drawings, the access cover or handwheel operator shall be extended to finish floor or grade.

Terminal backwater valves shall be provided with a hinged flapper valve and an inlet hub connection. The flapper valve shall be factory set to be fully closed in the normal position.

Ball-float backwater valves shall be provided with cast-iron body, removable bronze seat ring, neoprene seat and ball-float. Ball float backwater valves shall be provided with threaded inlet connection and threaded or no-hub outlet connection as appropriate for the piping system.

Cast-iron backwater valves shall be manufactured by Smith, Josam, Wade, or approved equal. PVC backwater valves shall be manufactured by NDS, Plastic Oddities, Inc, or approved equal.

2.6.10 Vent Flashings. Plumbing vent flashings shall be furnished and installed as indicated on the drawings.

2.7 PLUMBING FIXTURES AND ACCESSORIES.

2.7.01 General. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.

2.7.02 Water Closets. Water closets shall be of vitreous china, with an elongated bowl and siphon jet flushing action. The type and water use of water closets shall be as indicated on the drawings. All water closets shall be provided with anchor bolt caps. Flush valve type water closets shall be provided with top spud connections for flushometer valves. Flush tank type water closets shall be provided with factory installed tank liners. Field installed liner kits will not be acceptable. Water closets shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.02.01 Seats. Water closet seats shall be white, solid plastic, contoured, elongated open front type without cover, with concealed check and stainless steel hinges. The seats shall be manufactured by Kohler, American Standard, Eljer, Church, or approved equal.

2.7.02.02 Flush Valves. Flush valves for top spud type water closets shall be exposed type, with a chrome plated brass body, an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 1 inch (25 mm) NPT water supply connection. Flush valves shall be Sloan "Royal" Delaney, or approved equal.

2.7.02.03 Supply Set. A supply set consisting of a 1/2 inch (13 mm) NPT brass angle loose key stop valve, a copper supply tube, and an escutcheon plate shall be furnished for each tank type water closet. All supply components shall be polished chrome.

2.7.02.04 Chair Carriers. Wall-mounted water closets shall be provided with adjustable chair carriers. The carriers shall be suitable for the chase depth and piping arrangement and shall consist of a heavy-duty cast iron body, complete with a drainage fitting, pylon feet, a drainage nipple, fitting and fixture gaskets, a positioning frame or template, and mounting hardware. Chair carriers shall be manufactured by Smith, Josam, Wade, or approved equal.

2.7.03 Urinals. Urinals shall be of the type and water use as indicated on the drawings. Urinals shall be of vitreous china, wall mounted, with an elongated rim and washout flushing action, and shall be provided with a top spud connection for a flushometer valve. Urinals shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.03.01 Flush Valves. Flush valves shall be exposed type, of chrome plated brass with an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 3/4 inch (19 mm) NPT water supply connections. Flush valves shall supply a maximum of 1.0 gallon (3.8 L) per flush, and shall be Sloan "Royal 186-1", Delaney, or approved equal.

2.7.03.02 Supports. A fixture support system, including support legs, upper and lower bearing plates, and bearing studs shall be provided for urinals mounted on all walls other than masonry. Urinals mounted on masonry walls shall be provided with suitable anchor bolts. Urinal supports shall be manufactured by Smith, Josam, Wade, or approved equal.

2.7.04 Lavatories. Lavatory types, dimensions, and water use shall be as indicated on the drawings. Lavatories shall be of vitreous china, constructed with overflow drains and soap depressions. Countertop lavatories shall be self-rimming, and shall be provided with suitable adhesive and/or fastening clamps. Wall-mounted lavatories shall be drilled for a concealed arm carrier. Faucet drillings shall be 4 inches (100 mm) on center unless otherwise indicated. Lavatories shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.04.01 Faucets and Trim. Lavatory faucets shall be 4 inches (100 mm) on center, of polished chrome, with a vandal-resistant single-lever handle and all-brass or copper waterways. Each faucet shall be provided with a flow restrictor, a cast brass grid strainer or pop-up drain, and a 1-1/4 inch (32 mm) cast brass tailpiece. Supply sets consisting of 1/2 inch (12.5 mm) NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be furnished for each lavatory faucet. All supply components shall be polished chrome. Where indicated to be ADA-compliant and exposed to human contact, lavatory supplies shall be insulated. Lavatory faucets and supply sets shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.04.02 Traps. Lavatory traps shall be at least 1-1/4 inches (32 mm) in diameter, cast brass with polished chrome finish, with an escutcheon flange and a cleanout plug. Where indicated to be ADA-compliant and if exposed to human contact, lavatory traps shall be offset, insulated type.

When insulation is needed, lavatory supplies and traps may be pre-insulated or furnished with an insulation kit for field installation. Insulating material shall be flame retardant closed cell vinyl. The supply insulating kit shall be snap form type or shall be provided with ties. The trap insulation material shall not require the use of ties or mechanical fasteners to be held in place. Pre-insulated traps and supply insulation kits shall be McGuire Products "ProWrap", or approved equal. Trap and supply insulation kits shall be as manufactured by TRUEBRO Inc, or approved equal.

2.7.04.03 Supports. Wall-hung lavatories shall be provided with a complete fixture support system, including support legs, bearing plates, concealed arms, and anchor bolts. The support legs shall be mounted within the partition wall. For lavatories mounted on masonry walls, support legs may be omitted. Lavatory supports shall be manufactured by Smith, Josam, Wade, or approved equal.

2.7.05 Showers. Shower type, dimensions, and water use shall be as indicated on the drawings.

2.7.05.01 Built-up Shower Stalls. Each built-up shower stall shall be provided with a pressure-balanced single lever mixing valve, a shower head, an arm, and a flange. The shower valve shall include integral service stops and an adjustable stop screw. The shower head shall be of adjustable spray pattern type, with volume control, a swivel ball joint, and an integral flow control device. All exposed components shall be polished chrome.

2.7.05.02 Prefabricated Shower Modules, ADA Compliant. Prefabricated shower modules shall be complete units, and shall meet ADA requirements. Each unit shall consist of a one-piece reinforced acrylic enclosure with stainless steel grab bars on two sides, a folding slatted wood or nylon seat, a 1 inch (25 mm) diameter curtain rod, a 10 ounce/yd^2 (339 g/m^2) shower curtain with hooks, and a 2 inch (51 mm) chrome plated cast brass outlet drain. Each module shall be predrilled for a shower valve, a shower support rod, and a dome light. A pressure-balanced single-lever mixing valve, a hand-held shower head with swivel fitting, a 69 inch (1.7 m) stainless steel flexible hose, a support rod, an in-line vacuum breaker, and a 120 volt dome light shall be provided with each unit. Prefabricated shower modules shall be manufactured by Crane, Kohler, or approved equal.

2.7.05.03 Prefabricated Shower Modules. Prefabricated shower modules shall be provided as complete units. Each unit shall consist of a one-piece reinforced acrylic enclosure with a 1 inch (25 mm) diameter curtain rod, a 10 ounce/yd^2 (339 g/m^2) shower curtain with hooks, and a 2 inch (50 mm) chrome plated cast brass outlet drain. Each module shall be predrilled for a shower valve and dome light. A pressure-balanced single-lever mixing valve and a 120 volt dome light shall be provided with each unit. Prefabricated shower modules shall be manufactured by Crane, Kohler, or approved equal.

2.7.06 Stainless Steel Sinks. Sink dimensions, hole punching, material, metal gage, manufacturer and model shall be as indicated in the schedules.

Stainless steel sinks shall be seamless stainless steel, with smooth radius interior corners. Countertop mounted sinks shall be self-rimming with compartment and faucet deck recessed below the outer edge of the sink. All exposed surfaces of sinks shall be machine polished to a bright finish and the underside shall be fully undercoated. Sinks shall be provided with mounting clips, support legs, and all other hardware as indicated in the schedules. Stainless steel sinks shall be manufactured by Advance Tabco, Elkay, or approved equal.

2.7.06.01 Faucets. Sink faucets shall be polished chrome, with a vandal-resistant single-lever handle. All waterways shall be constructed of brass or copper. Faucets shall be provided with a brass spout, an aerator, and a flow restrictor. Supply sets consisting of 1/2 inch (12.5 mm) NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be provided. All supply components shall be polished chrome. Sink faucets and supply sets shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.06.02 Drain Assembly. All required drainage accessories, including strainers, tailpieces, and traps, shall be provided. Basket strainers shall be heavy gage stainless steel, with a removable conical strainer plate and a neoprene stopper. Tailpieces shall be chrome plated brass. Sink traps shall be at least 1-1/2 inches (38 mm) in diameter, cast brass, with polished chrome finish, an escutcheon flange, and a cleanout plug.

2.7.07 Mop Sinks and Service Sinks. Mop sink and service sink types, dimensions, manufacturers, and models shall be as indicated in the schedules.

Mop sinks shall be floor mounted, corner type, with a diagonal front, constructed of pearl gray terrazzo. Mop sinks shall be provided with an integral 20 gage (0.91 mm) thick stainless steel threshold cap, a 6 inch (150 mm) drop at threshold, and a shoulder at least 1-1/4 inches (32 mm) wide. A 3 inch (75 mm) cast brass drain and stainless steel strainer, and where indicated, a 20 gage (0.91 mm) thick stainless steel splash panel shall be provided for each sink. Mop sinks shall be manufactured by Stern-Williams, Fiat, or approved equal.

Service sinks shall be wall mounted, and shall consist of a 10 inch (254 mm) deep cast iron bowl coated with acid resistant enamel, a stainless steel rim guard, a plain or drilled back as indicated on the drawings, and a heavy gage metal wall bracket. Service sinks shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.07.01 Faucets. Sink faucets shall be rough plated brass, with lever handles, a threaded spout, a vacuum breaker, a wall brace, and a pail hook. The distance from the wall to the center of the spout outlet shall measure approximately 7-1/2 inches (190 mm). Sink faucets shall be as manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.07.02 Drain Assembly. Mop sinks shall be provided with a 3 inch (75 mm) cast brass drain and a stainless steel strainer. Service sinks shall be provided with a 3 inch (75 mm) cast iron P-type trap standard, with a stainless steel strainer, a cleanout plug, and a threaded outlet.

2.7.08 Emergency Fixtures. Emergency fixtures, including showers, eye/face washes, and combination shower/eye/face wash units shall be furnished and installed where indicated on the drawings. Emergency eyewash shall meet the ANSI Z358.1 Standard and shall provide a minimum tempered water flow of 0.4 gpm at a minimum of 30 psi. Fixture type, manufacturer, and model shall be as indicated in the schedules. Emergency fixtures shall be manufactured by Haws, Guardian, Encon, or approved equal.

Pedestal eyewash shall have a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, a chrome plated trap, and a universal emergency sigh. All necessary accessories required for a complete installation shall be provided.

Indoor emergency eyewash fixtures shall be wall mounted with a wall bracket, a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, a chrome plated trap, and a universal emergency sign. All necessary accessories required for a complete installation shall be provided.

Faucet mounted eyewash shall have a chrome plated brass finish, pull handle with graphics, aerated sprays, and up to 2" thick counter thickness. The unit shall have a dedicated tepid water supply, and shall be manufactured by Speakman, or approved equal.

Indoor ceiling-mounted emergency shower fixtures shall be suitable for vertical supply pipe and flush ceiling mounting, with a pipe support bracket, a chrome plated brass shower head, a stay-open ball valve, a stainless steel pull-rod actuator, and a universal emergency sign. The ball valve shall be located above the ceiling. All necessary piping, support brackets, escutcheons, and accessories required for a complete installation shall be provided.

Combination emergency shower/eye/face wash fixtures shall be pedestal mounted, with a stanchion, a floor flange, a deluge showers, an aerated eye/face wash, an eye/face wash dust cover, stay-open ball valves, interconnecting piping, and a universal emergency sign. The shower shall be stainless steel or ABS plastic with a stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel with push plate and foot pedal actuators.

Freezeproof emergency eye wash fixtures shall be wall mounted with a wall bracket, a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, and a universal emergency sign. The ball valve shall be located indoors, with an extension stem extending through the exterior wall to the push plate actuator. All necessary drain and bleed piping, wall sleeves, and accessories required for a complete installation shall be provided.

Freezeproof emergency shower fixtures shall be wall mounted, suitable for a horizontal supply pipe, with a pipe support bracket, a stainless steel or ABS shower head, a stay-open ball valve, and a universal emergency sign. The ball valve shall be located indoors, with an actuator extending through the exterior wall. All drain and bleed piping, wall sleeves, and accessories required for a complete installation shall be provided.

Freezeproof combination emergency shower/eyewash fixtures shall be pedestal mounted, with a stanchion, a floor flange, a deluge shower, an aerated eye/face washes, freezeproof stay-open valves, interconnecting piping, and a universal emergency sign. The shower and eye/face wash shall be stainless steel or ABS plastic with a stainless steel actuator. The entire unit shall be provided with self-regulating heating cable and shall be insulated with polyethylene foam insulation. The insulation shall be provided with a removable, UV resistant, ABS plastic jacket with gasketing and removable fasteners. Electric heating cable shall be suitable for the outdoor temperature and power supply indicated on the drawings.

An audible and visual alarm system shall be provided when indicated on the drawings. The alarm system shall activate based on water flow when either the emergency shower or eyewash fixture is operated. The water flow switch shall be provided with double-pole double-throw contacts rated 5 amperes at 125 volts, suitable for remote alarm annunciation. The audible alarm shall provide an intermittent signal rated at 90 dB at 10 feet. The alarm light shall be amber, flashing type. The alarm system shall be pre-wired and shall be furnished with all necessary junction boxes, conduit, wire, and accessories for a complete installation. The alarm system shall be suitable for a 120 volt power supply.

2.7.09 Wash Fountains. Wash fountain type, size, and finish shall be as indicated in the schedules. Wash fountains shall be precast terrazzo with a 9 inch (229 mm) deep bowl, a pedestal support, and stainless steel scuff plates and panels, and shall be suitable for wall or floor type water and waste connections, and a rear or centrally rising vent. Wash fountains shall be complete with a polished chrome liquid or powdered soap dispenser, a thermostatic mixing valve, combination stop/strainer check valves, and all other components required for proper operation. A foot, hand, or infrared control system shall be provided as indicated on the drawings. Infrared control systems shall include transformers as needed for operation on a 120 volt power supply. Wash fountains shall be manufactured by Bradley Corporation, or approved equal.

2.7.10 Electric Water Coolers. Electric water cooler type, capacity, manufacturer, and model shall be as indicated in the schedules. Water coolers shall be wall mounted, mechanically refrigerated type, and shall deliver 50°F (10°C) water at the specified rate, based on 80°F (27°C) inlet water temperature and a room temperature of 90°F (32°C). The water coolers shall consist of a heavy gage steel cabinet, an insulated cooling tank, a stainless steel receptor, copper water lines, a water pressure regulating valve, an adjustable thermostat, and a 3-wire power cord with a polarized plug. The refrigeration unit shall consist of a hermetically sealed spring mounted compressor and an air-cooled condenser. Electric water coolers shall be suitable for a 120 volt, 60 Hz, single phase power supply, shall be UL and ARI listed, and shall be manufactured by Elkay, Oasis, Halsey Taylor, or approved equal.

2.7.11 Food Waste Disposers. Food waste disposer motor size, power supply, and model shall be as indicated on the drawings. Disposers shall consist of stainless steel grinding chamber, grinding elements, impellers, and stopper. Disposers shall be provided with permanently lubricated bearings, a motor overload protector, a tailpiece, a 5 foot (1.5 m) 3-wire power cord with a polarized plug, and a service wrench. Disposers shall be UL listed and shall be manufactured by In-Sink-Erator, or approved equal.

2.8 PLUMBING EQUIPMENT.

2.8.01 General. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

2.8.02 Water Heaters and Accessories. Water heaters shall be furnished and installed where indicated on the drawings. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated in the schedules.

2.8.02.01 Commercial Grade Electric Storage Water Heaters. Electric storage water heaters shall be commercial type, with a glass-lined tank and one or more heating elements. The heater shall be provided with a cold water inlet tube, a magnesium anode, polyurethane foam insulation, a drain valve, and adjustable thermostats. Heating elements shall be immersion type, incoloy sheathed, low or medium watt density, and shall be field replaceable. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). Heater tanks larger than 70 gallons (265 L) shall be provided with an inspection port. Each heater shall be equipped with an ASME rated pressure-temperature relief valve of suitable capacity. Heaters shall be UL and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. Electric storage water heaters shall be manufactured by State Industries Inc., A. O. Smith, Lockinvar, or approved equal.

2.8.02.02 Industrial Grade Electric Storage Water Heaters. Electric storage water heaters shall be industrial type, with a nickel-lined tank and one or more heating elements. Heaters shall be provided with a cold water inlet tube, high density fiberglass insulation, a drain valve, and adjustable thermostats. Heating elements shall be immersion type, incoloy sheathed, low or medium watt density, and shall be field replaceable. Heater tank shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). The heater tanks shall be provided with an inspection port at least 12 inches (300 mm) in diameter. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heater shall be UL and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. The electric storage water heaters shall be manufactured by PVI Industries Inc, or approved equal.

2.8.02.03 Electric Instantaneous Water Heaters. Instantaneous water heaters shall be tankless type and shall heat water on demand as determined by an integral flow switch. Heaters shall be suitable for operating water pressures of 25 to 150 psig (14 to 1034 kPa gauge), and shall be provided with compression type tubing connections. Heater elements shall be constructed of stainless steel or glass reinforced plastic, and shall be replaceable. If required by applicable codes, each heater shall be provided with a temperature and pressure relief valve. Heaters shall be provided with thermostatic control. Electric instantaneous water heaters shall be UL listed and shall be manufactured by Chronomite Laboratories Inc., Eemax, or approved equal.

2.8.02.04 Commercial Grade Gas Fired Water Heaters. Gas fired water heaters shall be commercial, storage type, with a glass-lined tank and a natural or propane gas burner as indicated on the drawings. Heaters shall be provided with a cold water inlet tube, a magnesium anode, high density fiberglass insulation, a drain valve, a flue damper, and an adjustable thermostat. The heater burner shall be atmospheric type, constructed of aluminized steel, and shall be suitable for a minimum gas supply pressure as indicated on the drawings. The burner shall be provided with a gas pressure regulator, a manual reset safety shutoff, and an intermittent electronic ignition control system. Burner operation shall be interlocked with the flue damper to prevent burner and pilot ignition until the flue damper is proven open. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). Heater tanks larger than 70 gallons (265 L) shall be provided with an inspection port. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heaters shall be UL, AGA, and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. Gas fired storage water heaters shall be manufactured by State Industries, A. O. Smith, Lockinvar, or approved equal.

2.8.02.05 Industrial Grade Gas Fired Water Heaters. Gas fired water heaters shall be industrial, storage type, with a nickel-lined tank and a natural or propane gas burner as indicated on the drawings. Heaters shall be provided with a cold water inlet tube, a magnesium anode, high density fiberglass insulation, a drain valve, and an adjustable thermostat. The heater burner shall be forced draft type constructed of cast aluminum, and shall be suitable for a minimum gas supply pressure as indicated on the drawings. The burner shall be provided with a gas pressure regulator, an automatically reset safety shutoff device, and an intermittent electronic ignition control system. The burner combustion chamber shall be submerged, utilizing a minimum of two passes. Heater tank shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). The heater tanks shall be provided with an inspection port at least 12 inches (300 mm) in diameter. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heaters shall be UL, AGA, and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. Gas fired storage water heaters shall be manufactured by PVI Industries, Inc, or approved equal.

2.8.02.06 Water Heater Flues. A complete flue system shall be provided for each gas fired water heater. Unless otherwise required to maintain the listing of the heater, water heaters utilizing atmospheric burners or fan assisted heaters which operate under a negative flue pressure shall be provided with a Type 'B' flue system. Water heaters utilizing forced draft burners which pressurize the flue shall be provided with a pressurized flue system. Flues shall be as specified in Master Specification Section 15500, Heating, Ventilating and Air Conditioning.

2.8.02.07 <u>Circulating Pump</u>. A circulating pump shall be furnished and installed where indicated on the drawings. Pump capacity, power requirements, manufacturer, and model shall be as indicated on the drawings.

The circulating pump shall be an in-line unit with a bronze body, bronze fitted, mechanical seals, a stainless steel or ceramic shaft, and at least 1/2 inch (13 mm) NPT connections. The circulating pump shall be controlled by a 7-day time clock provided with the pump. The time clock shall be suitable for a 120 volt single phase power supply, and shall have contacts rated for 10 amperes ac. The circulating pump shall be manufactured by Bell & Gossett, Thrush, Taco, or approved equal.

2.8.02.08 <u>Thermometers</u>. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle", or approved equal.

Thermometers shall be bimetal type and shall have a dial at least 4-1/2 inch (114 mm) diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200°F (-10 to 110°C).

Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have 3/4 inch (20 mm) NPT thread mounts, a minimum pressure rating of 250 psig (1725 kPa gauge), and a nominal 4 inch (100 mm) insertion length.

2.8.03 <u>Neutralization Tanks</u>. Neutralization tanks shall be furnished and installed where indicated on the drawings. Tank volume, connection sizes, manufacturer, and model shall be as indicated in the schedules.

Neutralization tanks shall be of heavy-duty construction, rotomolded in one piece from polyethylene resins and equipped with a bolt-down cover of the same material, fastened with stainless steel bolts and washers. Inlet, outlet, and vent fittings molded from the same resins as the tank shall be triple-welded to the tank body at the locations indicated on the drawings. A full diameter flanged extension constructed of the same material as the tank shall be provided where required to raise the access cover to at or just below the floor level as indicated on the drawings. The tank shall be filled with hard limestone or marble chunks, 2 to 3 inches (50 to 75 mm) in diameter to the level recommended by the manufacturer. Neutralization tanks shall be manufactured by Enfield, Orion, Town & Country Plastic, Inc, or approved equal.

2.8.04 Hose Reels. Hose reels shall be furnished and installed at the locations indicated on the drawings. Hose reel type, capacity, manufacturer, and model shall be as indicated in the schedules.

Each hose reel shall be provided complete with a hose storage drum, a handle crank winding mechanism, a spring-actuated pin lock, and a heavy duty frame suitable for anchoring to concrete or masonry wall or floor supports. When indicated on the drawings, hose reels shall be provided with a water supply swivel joint rated at 600 psig (4,130 kPa gauge). The hose storage drum shall be provided with a brass male hose adapter suitable for use with the specified hose. The hose reels shall be manufactured by Hannay, or approved equal.

2.8.05 Hoses. Hoses shall be furnished at the locations indicated on the drawings. Hose type, diameter, manufacturer, and model shall be as indicated in the schedules.

Unless otherwise indicated, each hose shall be provided with one male swivel type brass hose connector, one female brass hose connector, and one regulating wash-up spray nozzle. Spray nozzles in 1 inch (25 mm) and 1-1/2 inch (38 mm) sizes shall be Potter-Roemer Inc. "Series 2970" with a cast brass body, a rubber bumper, and a female hose thread, or approved equal.

Type 1 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig (1030 kPa gauge) working pressure. The hose shall consist of 1-1/2 inch (38 mm) ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 1 hoses shall be Gates Rubber Company "Dolphin", or approved equal.

Type 2 hoses shall be non-collapsible, suitable for water service and shall be rated for 130 psig (900 kPa gauge) working pressure. The hose shall consist of 3/4 inch (19 mm) or 1 inch (25 mm) ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 2 hoses shall be Gates Rubber Company "Industrial Wearmaster", or approved equal.

Type 3 hoses shall be non-collapsible, suitable for hot water service and shall be rated for 200 psig (1380 kPa gauge) working pressure. The hose shall consist of 1 inch ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. The hose shall have an integrated nozzle. The hose end opposite the nozzle shall be furnished with a female thread brass hose connector with swivel. Type 3 hoses shall be Gates Rubber Company "113S", or approved equal.

Type 4 hoses shall be suitable for lay flat water discharge service and shall be rated for 75 psig (500 kPa gauge) working pressure. The hose shall be 1-1/2 inch (38 mm) ID with a heavy-duty polyvinyl chloride (PVC) body and synthetic, high tensile textile cord reinforcement. Type 4 hoses shall be Gates Rubber Company "Masterflex 500", or approved equal.

2.8.06 Oil Interceptor. An oil interceptor shall be furnished and installed where indicated on the drawings. Interceptor capacities, connections, manufacturer, and model shall be as indicated in the schedules.

The oil interceptor shall be of cast iron with an acid resisting coating inside and outside, an adjustable gravity drawoff, a trap with cleanout, 4 inch (102 mm) inlet and outlet connections, vent connections, a removable baffle and sediment bucket, an internal air relief/flow control fitting with access box, and a gasketed cast iron scoriated cover with one bolt securing T-handle. A suitable steel extension shall be provided to raise the access cover to the floor level. The interceptor shall bear the Plumbing and Drainage Institute (PDI) seal of approval and shall be manufactured by Smith, Josam, Wade, or approved equal.

2.8.07 Flammable Waste Interceptor. A flammable waste interceptor suitable for containing oil and other flammable liquids shall be furnished and installed where indicated on the drawings.

The flammable waste interceptor shall consist of a steel or cast iron shell at least 3/16 inch (5 mm) thick, a 4 inch (100 mm) inlet and outlet, and 3 inch (75 mm) vent connections located as indicated on the drawings and as stipulated by the authority having jurisdiction. Steel interceptors shall be coated inside and outside with two coats of black asphaltum.

The interceptor shall maintain a liquid depth of at least 36 inches (0.9 m), and shall have a liquid retention volume of at least 35 cubic feet (1 cubic meter). The inlet piping shall terminate with a 90 degree elbow to 3 inches (75 mm) below the liquid level. The discharge piping shall consist of a 90 degree elbow and pipe terminating 18 inches (450 mm) below the liquid level.

A suitable steel or cast iron extension shall be provided to raise the access cover to the floor level, and a gasketed vaportight steel or cast iron access cover with lifting rings shall also be provided. The cover shall be at least 24 inches (600 mm) in diameter and shall be suitable for a live load of at least 150 psf (7.2 kPa).

2.8.08 Expansion Tanks. Expansion tanks shall be furnished and installed where indicated on the drawings. Tank capacities, connections, manufacturer, and model shall be as indicated in the schedules.

Expansion tanks shall be welded steel diaphragm type, ASME tested and stamped for a working pressure of 125 psig (862 kPa gauge), with a flexible diaphragm and a charging valve. Floor-mounted tanks shall be provided with a suitable mounting base. The tanks shall be suitable for use with potable water and shall be factory pre-charged to the indicated pressure. Expansion tanks shall be manufactured by Amtrol, or approved equal.

2.8.09 Water Storage Tank. The water storage tank shall have the capacity and dimensions as indicated in the schedules. The tank shall be welded steel, glass or thermosetting polymer lined, suitable for use with potable water, and shall be ASME stamped for a working pressure of 125 psig (862 kPa gauge). The tank shall be provided with legs for vertical mounting, a magnesium anode, threaded connections for 2 inch (50 mm) water inlet and outlet, a 1 inch (25 mm) relief valve, and a 3/4 inch (20 mm) drain valve. The outlet and relief valve connections shall be located near the top of the tank; the inlet and drain valve connections shall be located at the bottom of the tank. An ASME rated pressure-temperature relief valve and drain valve shall be provided with the tank. The exterior of the tank shall be thoroughly cleaned, primed, and finished with baked enamel. The water storage tank shall be manufactured by A. O. Smith, PVI, or approved equal.

2.8.10 Automatic Water Softener Unit. An automatic water softener unit shall be furnished and installed where indicated on the drawings. Softener capacities, connections, manufacturer, and model shall be as indicated in the schedules.

The automatic water softener unit shall be furnished with resin tank(s), a brine tank, resin, an electric control system, and all other accessories and appurtenances required for a complete automatic system. The water softening unit shall be manufactured by Culligan, Bruner, or approved equal.

2.8.10.01 Construction. The water softener shall be a factory-assembled, pressure-type consisting of a single unit with resin tank(s) and one brine tank.

Resin tanks shall be constructed of plastic, fiberglass reinforced plastic, or steel with plastic internal liner, and shall be designed for a working pressure of 100 psig (690 kPa gauge). The resin tanks shall be provided with a distribution pipe system to evenly distribute water flow across the media bed and ensure maximum water softening capacity.
The brine tank shall be constructed of high density polyethylene and shall be provided with a cover, a brine fill/discharge valve, an overflow connection, pipe fittings, and required accessories.

2.8.10.02 Media. The softening media shall be high-capacity, sulfonated polystyrene resin that is stable over the entire pH range with good resistance to bead fracture from attrition or shock. The resin shall have a capacity of 30,000 grains of calcium carbonate hardness per cubic foot (66.6 g/L) of resin when regenerated with 15 lbs (6.8 kg) of salt.

2.8.10.03 Controls. The water softening unit shall be provided with a factory installed, automatic, electrically operated control system as indicated on the drawings.

Timer based control systems shall consist of an electric timer which shall initiate regeneration cycles at adjustable time periods.

Timer and flow based control systems shall consist of an electric timer in conjunction with a manually adjustable totalizing flow meter. The system shall initiate regeneration cycles based on water volume or fixed time periods.

Sensor based control systems shall be the solid-state sensor type which initiates regeneration cycles based on sensing water hardness.

Softening units with two resin tanks shall automatically alternate to the standby resin tank at the time of regeneration and shall operate that tank until either the timer or the flow meter senses regeneration of that unit.

All controls shall be capable of manual adjustment and operation. All controls shall be suitable for operation on a 120 volt single phase power supply.

2.9. COLOR Vitreous china, cast iron, enameled steel, and acrylic plumbing fixtures shall be white unless otherwise indicated. Other plumbing fixtures shall be the manufacturers standard color. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.

2.10 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3.3 INSTALLATION. Piping, fixtures, equipment, and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies and as indicated on the drawings. Piping penetrations through fire-rated floors and walls shall be provided with fire-rated sleeves, sealants, and devices as necessary to maintain the rating of the assembly.

Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.

Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems as specified Master Specification Section 15065, Miscellaneous Steel Pipe, Tubing and Accessories.

Fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building.

Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.

3.3.01 Water Supply Piping and Accessories. Water hammer arresters shall be provided in the hot and cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the drawings, arresters shall be located and sized by Contractor in accordance with PDI Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.

Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches (150 mm) of the fixture.

3.3.02 Drainage and Vent Piping and Accessories. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches (75 mm) in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot (2 percent); horizontal sanitary drainage piping larger than 3 inches (75 mm) in diameter shall be installed at a uniform slope of 1/8 inch per foot (3 mm/300 mm); horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot (3 mm/300 mm).

All cast iron, polypropylene, and PVC sanitary and storm drainage piping which is buried beneath floors shall be encased in at least 6 inches (150 mm) of concrete when required. A joint shall be provided in the piping within 12 inches (300 mm) of each end of the encasement.

Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings. Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

Plumbing vents through roofs shall be located at least 12 inches (300 mm) from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches (150 mm) above the flood level rim of the fixture served before offsetting horizontally.

Floor drains shall be adjusted to the correct elevation for proper drainage. Floor cleanouts shall be installed flush with the finished floor. Heads of fastening screws shall be flush with the cover or grate surface.

Cleanouts on sanitary and storm piping inside structures shall be located where indicated on the drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in sanitary and storm drain risers shall be located 12 inches (300 mm) above the finished floor.

Unless otherwise indicated, floor cleanout size shall equal the line size for 4 inch (100 mm) and smaller drainage piping, and 4 inches (100 mm) in diameter for drains larger than 4 inch (100 mm). Proper clearance shall be provided for access to cleanouts.

Floor drains, trench drains, floor sinks, and bell-up drains indicated to be equipped with traps shall be provided with deep seal "P" traps located as close to the drain as possible.

Roof drains shall be set at the proper level for flashing and drainage and shall be securely attached to the roof decks to prevent movement. Overflow roof drain dams or standpipes shall be set at an elevation 2 inches (50 mm) above the low point of the roof.

3.3.03 Plumbing Fixtures and Accessories. Plumbing fixtures shall be set level and plumb, and shall be securely attached to the floor or wall. Unless otherwise indicated on the drawings, each fixture shall be mounted at the height recommended by the manufacturer. Where required to be in compliance with ADA, fixtures shall be mounted at the heights established by the Federal Government.

Fixtures shall be sealed to the floor or wall with a sealant as specified in Master Specification Section 07600, Caulking and Sealers. The color of sealant shall match the color of the fixture.

Fixture traps shall be easily removable for servicing and cleaning. Escutcheons shall be placed at all locations where fixture supply or drain piping penetrates walls, floors, or ceilings.

Water piping at stop valves, shower heads, and flush valves shall be rigidly secured to blocking. Drop-ear elbows shall be used whenever possible. All water supply piping shall be cleaned and flushed before the plumbing fixtures are installed.

3.3.04 Plumbing Equipment. Plumbing equipment shall be installed in accordance with the manufacturer's recommendations. Adequate clearance shall be provided for access to all components which may require adjustment, servicing, or replacement.

Water heaters shall be installed in accordance with AGA, NSF, NFPA, and UL requirements. Storage type water heaters shall be cleaned and flushed before being connected to the potable water system. Water heater relief valves shall be piped to the nearest drain or as indicated on the drawings, and shall terminate the appropriate air gap distance above the drain.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.

Field performance testing of the plumbing piping systems shall conform to Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 ADJUSTING. All flush valves and other devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3.6 PROTECTION. Plumbing fixtures, equipment, and appurtenances shall be protected from damage immediately after installation. Plumbing fixtures shall not be used during the construction.

3.7 CLEANING. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer. All faucet aerators shall be removed, cleaned, and reinserted.

Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3.8 DISINFECTION. Before the potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:

1. The system shall be purged with clean potable water until all dirt and other substances are flushed from the system.

2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million (50 mg/L) of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million (200 mg/L) of available chlorine and allowed to stand for 3 hours.

3. The system shall be purged with clean potable water until the chlorine is flushed from the system.

4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

3.9 OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as indicated.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

SECTION 15430

BACK FLOW PREVENTERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installing of backflow preventers and associated appurtenances.

1.2 RELATED DOCUMENTS. Drawings and general provisions of the Contract, including Division 1 Specification Section, apply to this Section.

1.3 SUBMITALS.

1.3.01 Drawings and Data. Complete fabrication and assembly drawings, together with detail specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Mater Specification Section 01080, The data and specifications for each unit shall include, but shall not be limited to the following:

Name of Manufacturer.

Type and model.

Net weight.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

Manufacturer shall submit certification that each backflow preventer and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of backflow preventer.

Contractor shall submit results of all pressure and leakage testing.

Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manual shall be submitted in accordance with Master Specification section 01160, Training and Operation Manuals.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS*.* Shall be Febco-860, Watts Regulator Company–909, or as approved.

Provide an air gap fitting between relief valve outlet and drain line. Provide all required drain piping and fittings from the relief valve outlet to the nearest floor drain or other approved outlet.

2.1.01 Reduced Pressure Backflow Preventers. AWWA/ANSI C511; ductile iron body, epoxy coated interior and exterior, and flagged resilient seated gate valve on each end of the device. Flange diameter and drilling shall confirm to ANSI/ ASTM B16.1, Class 125.

2.1.02 Double Check Valve Assemblies. ANSI/ASSE 1012; bronze body with corrosion- resistant internal parts and stainless steel springs; and two independently operating check valves.

PART 3 – EXECUTION

3.1 INSTALLATION. Install in accordance with manufacturer's instructions.

Pipe relief from backflow preventer to nearest drain.

End of Section

SECTION 15480

GENERAL SERVICE COMPRESSED AIR PIPING

PART 1 - GENERAL

1.1 SCOPE. This section covers general service compressed air piping to be installed in the Rack and Grit building indicated in the Contract Documents.

1.2 SUMMARY. This Section includes piping and related specialties for general-service compressed-air systems operating at 100 psig (1380 kPa) and less.

1.3 RELATED SECTIONS. Related Sections include the following:

Division 15 Section 15130- “Indicating Devices” for thermometers and pressure gages.

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS.

ABS: Acrylonitrile-butadiene-styrene plastic.

CR: Chlorosulfonated polyethylene synthetic rubber.

EPDM: Ethylene-propylene-diene terpolymer rubber.

FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

HDPE: High-density polyethylene plastic.

Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 125 psig (860 kPa) and less.

1.4 SUBMITTALS. All submittals required in this section shall be provided in accordance with Master Specification Section 01080, Project Submittals, unless otherwise indicated.

1.4.01 Product Data. Submit product data for the following:

Pipes, tubes, and fittings.

Flexible pipe connectors.

Safety valves.

Pressure regulators.

Filters.

Automatic drain valves.

Hose couplings.

Hose assemblies.

1.4.02 Coordination Drawings. For general-service compressed-air systems. Include relationship to other services that serve same work area.

1.4.03 Brazing Certificates. As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.4.04 Welding Certificates. As required by ASME Boiler and Pressure Vessel Code, Section IX.

1.4.05 Field quality-control test reports. Submit reports with results of field quality-control tests.

1.5 QUALITY ASSURANCE.

1.5.01 Brazing. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

1.5.02 Welding. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1.5.03 Standards. Comply with the following:

ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection.

2.1.01 Available Manufacturers. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPING MATERIALS. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, AND FITTINGS.

2.3.01 Schedule 80, Steel Pipe. ASTM A 53/A 53M, Type E or S, Grade A or B, black or hot dip, zinc coated. Provide Type S, Grade B, and hot-dip zinc-coated pipe options if indicated.

2.3.01.01 Steel Nipples. ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 80, galvanized seamless steel pipe. Include ends matching joining method.

2.3.01.02 Malleable-Iron Fittings. ASME B16.3, Class 150 , threaded. Provide Class 300 and galvanized finish if indicated.

2.3.01.03 Malleable-Iron Unions. ASME B16.39, Class 150 , threaded. Provide Class 300 if indicated.

2.3.01.04 Steel-Piping Grooved-End Fittings. ASTM A 47/A 47M, malleable-iron casting; ASTM A 106, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe; and made by keyed-coupling manufacturer. Provide galvanized finish if indicated. Available Manufacturers:

Central Sprinkler Co.; Central Grooved Piping Products.

Grinnell Corp.

Star Pipe Products, Inc.; Star Fittings Div.

Victaulic Corp. of America.

Ward Manufacturing, Inc.

2.3.02 Transition Couplings for Metal Piping. Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3.03 Flexible Pipe Connectors. Corrugated tubing with wire-braid covering. Available Manufacturers:

ANAMET Inc.

Flex-Hose Co., Inc.

Flexicraft Industries.

Hyspan Precision Products, Inc.

Mercer Rubber Co.

Metraflex, Inc.

Proco Products, Inc.

Unaflex, Inc.

2.3.04 Stainless-Steel-Hose/Steel Pipe Flexible Pipe Connectors. Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

Working-Pressure Rating: 200 psig (1380 kPa) minimum.

End Connections NPS 2 (DN 50) and Smaller: Threaded steel pipe nipple.

End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

Refer to Division 15 Section 15019 "Exposed Piping Installation" for joining materials not in this Section.

2.4 VALVES.

2.4.01 General-Duty Valves. Refer to Division 15 following sections:

Section 15091, "Miscellaneous Ball Valves" "Valves"

Section 15093, "Check Valves"

Section 15096, "Globe Valves"

Section 15100, "Miscellaneous Valves"

2.5 SPECIALTIES.

2.5.01 Safety Valves. ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

Pressure settings to be higher than discharge pressure and same or lower than receiver pressure rating.

2.5.02 Air-Main Pressure Regulators. Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig (1725-kPa) inlet pressure, unless otherwise indicated.

Type: Pilot operated.

2.5.03 Air-Line Pressure Regulators. Aluminum alloy or plastic body, diaphragm operated, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 100-psig minimum inlet pressure, unless otherwise indicated.

2.5.04 Mechanical Filters. Two-stage, mechanical-separation-type, air-line filters in sizes and ratings indicated. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock.

2.5.05 Automatic Drain Valves. Corrosion-resistant metal body and internal parts, rated for 100-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.5.06 Hose Couplings. Shall be Chicago Fitting type. Assembly with locking-mechanism feature for connection and disconnection of compressed-air hose.

Available Manufacturers:

Aeroquip Corporation.

Bowes Manufacturing, Inc.

Parker Hannifin Corporation; Fluid Connectors Group; Quick Coupling Div.

Rectus GMBH; Parker Div.

Schrader-Bridgeport; Amflo Div.

Schrader-Bridgeport/Standard Thomson.

Snap-Tite, Inc.

TOMCO Products Inc.

Tuthill Corporation; Hansen Coupling Div.

2.5.07 Hose Assemblies. Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 200-psig (2070-kPa minimum working pressure, unless otherwise indicated.

Hose: Reinforced single wire-braid, CR-covered hose for compressed-air service.

Hose Clamps: Stainless-steel clamps or bands.

Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with serrated ends for connecting two sections of hose.

Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with serrated ends for connecting two sections of hose.

2.6 IDENTIFICATION. Refer to Division 15 Section 15825 "Mechanical Identification" for identification of piping, valves, gages, and specialties.

PART 3 - EXECUTION

3.1 PREPARATION.

3.1.01 Interruption of Existing Compressed-Air Service. Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

Notify Owner not less than 25 days in advance of proposed interruption of compressed-air service.

Do not proceed with interruption of compressed-air service without Owner's written permission.

3.2 PIPING APPLICATIONS. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below, unless otherwise indicated.

3.2.01 Joining of Dissimilar Metal Piping. Use dielectric fittings. Refer to Division 15 Section 15019 "Exposed Piping Installations" for dielectric fitting types.

NPS 2 (DN 50) and Smaller: Dielectric unions.

NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flanges.

3.2.02 Specialty and Equipment Flanged Connections. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

3.2.03 General-Service Compressed-Air Piping Between Air Compressors And Air Receivers. Use metal general-service compressed-air piping between air compressors and air receivers. Use of plastic piping for this application is prohibited.

3.2.04 Low-Pressure Compressed-Air Piping between Air Compressors and Receivers. Use any of the following piping materials for each size range:

NPS 2 (DN 50) and Smaller: Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

3.2.05 Low-Pressure Compressed-Air Distribution Piping. Use any of the following piping materials for each size range:

NPS 2 (DN 50) and Smaller: Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

3.2.06 Receivers. Use the following piping materials for each size range:

NPS 2 (DN 50) and Smaller. Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

NPS 2-1/2 to NPS 4 (DN 65 to DN 100). Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

3.3 VALVE APPLICATIONS.

3.3.01 General-Duty Valves. Refer to Division 15 Section 15010 "Valve Installation" for metal general-duty valves. Use metal valves, unless otherwise indicated.

3.3.01.01 Metal General-Duty Valves. Use valve types specified in the schedule of valves in Division 15 Section 15010 "Valve Installation" according to the following:

Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.

Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

Grooved-end valves may be used with grooved-end piping and grooved joints.

3.4 PIPING INSTALLATION. Refer to Division 15 Section 15019 "Exposed Piping Installation” for basic piping installation.

Install air and drain piping with 1 percent slope downward in direction of airflow.

Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

Install flexible pipe connector on each connection to air compressors.

Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver; install according to Division 15 Section 15130 "Indicating Devices."

Install pipe expansion joints and anchors according to Division 15 Section 15019 "Exposed Piping Installation."

3.5 VALVE INSTALLATION. Refer to Division 15 Section 15019 "Exposed Piping Installation" for basic piping and valve installation.

Install metal general-duty valves according to Division 15 Section 15010 "Valve Installation."

Install plastic valves according to plastic piping manufacturer's written instructions.

Install shutoff valve at each connection to and from general-service compressed-air specialties, equipment, and accessories. Install strainer if indicated.

Install check valves to maintain correct direction of fluid flow to and from compressed-air piping specialties and equipment.

Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

Install automatic drain valves on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

Install safety valves where recommended by specialty manufacturers.

3.6 JOINT CONSTRUCTION. Refer to Division 15 Section 15019 "Exposed Piping Installation" for basic piping joint construction.

Pressure-Seal Joints. Select correct type of O-ring seals. Make joints with fitting manufacturer's tools and according to fitting manufacturer's written instructions.

Grooved Joints. Select correct type of gasket. Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling manufacturer's written instructions. Do not apply lubricant to pre-lubricated gaskets.

Copper Tubing Joints. Join copper tubing with brazed joints. Use silver-composition or copper-phosphorus-composition filler metal and comply with CDA's "Copper Tube Handbook," Section VII, "Brazed Joints."

Dissimilar Metal Piping Material Joints. Use dielectric fittings.

3.7 HANGER AND SUPPORT INSTALLATION. Refer to Division 15 Section 15140 "Pipe Supports" for pipe hanger and support devices. Install the following:

Vertical Piping: MSS Type 8 or 42, clamps.

Individual, Straight, Horizontal Piping Runs: According to the following:
100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.

Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

Base of Vertical Piping: MSS Type 52, spring hangers.

Install supports according to Division 15 Section 15140 "Pipe Supports."
Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

Support vertical piping and tubing at base and at each floor.

Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

Install hangers for Schedule 80, steel piping with the following maximum horizontal spacing and minimum rod diameters:

NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

NPS 1-1/2 (DN 40): 12 feet (3.7 m) with 3/8-inch (10-mm) rod.

NPS 2 (DN 50): 13 feet (4 m) with 3/8-inch (10-mm) rod.

NPS 2-1/2 (DN 65): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.

NPS 3 (DN 80): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

NPS 3-1/2 (DN 90): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.

NPS 4 (DN 100): 17 feet (5.2 m) with 5/8-inch (16-mm) rod.

Install supports for vertical, Schedule 80, steel piping every 15 feet (4.6 m).

NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.

NPS 3 (DN 80): 68 inches (1730 mm) with 1/2-inch (13-mm) rod.

NPS 4 (DN 100): 76 inches (1900 mm) with 1/2-inch (13-mm) rod.

All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C)

NPS 1/2 (DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.

NPS 3/4 (DN 20): 36 inches (910 mm) with 3/8-inch (10-mm) rod.

NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.

NPS 1-1/4 (DN 32): 43 inches (1090 mm) with 3/8-inch (10-mm) rod.

NPS 1-1/2 (DN 40): 49 inches (1245 mm) with 3/8-inch (10-mm) rod.

NPS 2 (DN 50): 55 inches (1400 mm) with 3/8-inch (10-mm) rod.

NPS 3 and NPS 4 (DN 80 and DN 100): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.

3.8 CONNECTIONS. Drawings indicate general arrangement of piping, fittings, and specialties.

Install piping adjacent to specialties and equipment to allow service and maintenance.

Connect piping to air compressors, accessories, and specialties with shutoff valve and union or flanged connection.

3.9 LABELING AND IDENTIFICATION. Install identifying labels and devices for general-service compressed-air piping systems. Refer to Division 15 Section 15825 "Mechanical Identification" for labeling and identification materials.

3.10 FIELD QUALITY CONTROL. Perform the following field tests and inspections and prepare test reports:

Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.

Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

Repair leaks and retest until no leaks exist.

Report results in writing.

End of Section

SECTION 15482

LABORATORY COMPRESSED AIR SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers laboratory compressed air systems to be installed in the locations indicated in the Contract Documents.

The compressed air package shall include a compressor, an electric drive motor, a motor starter, belts, sheaves, safety guards, receiver, air dryer, controls, traps, valves, piping, baseplate, and all accessories and appurtenances specified, indicated on the drawings, or otherwise required for a complete, properly operating installation.

All required interconnecting air piping and valves between package components shall be provided under this section.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Components of the compressed air equipment package shall be the latest standard products of manufacturers who regularly produce equipment of this type.

All components of the compressed air equipment package shall be shop assembled on a common baseplate. The arrangement shall permit access from the front and ends of the package for maintenance of components.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Power Supply. Power supply to the compressors will be 480 volts, 60 Hz, 3 phase. Power supply to the dryer will be 120 volts, 60 Hz, single phase.

1.3 SUBMITTALS. Complete assembly and installation drawings, together with detailed specifications and data covering all equipment and accessories furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Electrical schematics, wiring diagrams, and panel layout drawings for compressor controls shall be included. Data and specifications for each unit shall include, but shall not be limited to, the following:

Baseplate

Overall dimensions.

Number, size, and location of structural members.

Thickness of top plate.

Number, size, and location of grout openings.

Drawings indicating pipe routing, traps, and valve locations.

Compressor

Manufacturer.

Type and model.

Piston speed.

Dimensions.

Weight, including motor.

Performance data at variable discharge pressures.

Bearing data.

Motors

Manufacturer.

Type and model.

Horsepower (kW) rating and service factor.

Temperature rating.

Full load rotative speed.

Type of bearings and lubrication.

Full load current.

Locked rotor current.

Efficiency at nameplate rating and at operating point.

Power factor at nameplate rating.

Receiver

Capacity.

Pressure rating.

Dimensions.

Connection sizes and locations.

Verification of ASME Code stamp.

Air Dryer

Manufacturer.

Model.

Performance data.

Pressure drop.

1.4 OPERATION AND MAINTENANCE MANUALS. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.6 SPARE PARTS. The following spare parts shall be furnished for each compressed air equipment package:

Part Description	Number Required
Intake air filter elements	2

V-belts	2 matched sets
Inlet valve assembly	1
Inlet valve springs	1 set
Discharge valve assembly	1
Discharge valve springs	1 set
Piston rings	1 set for each size piston

Spare parts shall be suitably packaged in accordance Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The system shall supply compressed air to laboratory outlets only. The air shall be dry and oil free.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The performance and design requirements shall be as indicated.

The approximate elevation of the site will be as indicated on the drawings. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.3 CONSTRUCTION.

2.3.01 Compressors. The compressors shall be single or two-stage as indicated, air-cooled reciprocating type and shall deliver oil-free air. Pistons shall be fabricated from materials which do not require oil lubrication. Cylinders and crankcases shall be of cast iron construction. Piston rings shall be teflon. Compressor cylinder valves shall be of the finger, channel, leaf, or ring type and shall be fabricated from corrosion-resistant materials suitable for nonlubricated service. Cylinders and cylinder heads shall be designed so that the compressor sheave provides all required external forced air circulation. The compressors shall be constructed with a distance piece between the compression cylinder and the crankcase lubricant system. The distance piece shall consist of an atmospheric chamber arranged to drain back into the crankcase. Portions of the piston rod in contact with the lower seal shall not enter the upper seal area. A collar shall be provided on the piston rod to prevent oil from traveling along the rod. Piston rod packing shall be teflon or carbon, nonlubricated type.

Each crankshaft shall be cradle-mounted with antifriction roller or ball type main bearings. Connecting rod bearings shall be steel backed, babbitt-lined, insert type plain bearings. Connecting rod and crankshaft bearings shall be lubricated by a force feed positive lubrication system. A lubrication system pressure gauge, of the compressor manufacturer's standard size and range, shall be furnished with each compressor.

Each compressor shall be driven by an electric motor connected to the compressor through a V-belt drive.

2.3.02 Package Receiver. The receiver shall be of all welded construction with semi-ellipsoidal heads and leg supports for vertical mounting on the common baseplate. The receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp.

The receiver shall be provided with piping connections for inlet, outlet, drain, safety valve, compressor control, receiver vent, and cleanout opening. The receiver shall be hot-dip galvanized and shall have an automatic float-operated condensate drain trap.

2.3.03 Air Dryer. The air dryer shall be of the air-cooled noncycling refrigerant type and shall produce a 33 to 39°F (1 to 4°C) pressure dew point at the heat exchanger exit when operating continuously at the design conditions. The air dryer shall be Hankison Refrigifilter "Model 8025", or approved equal.

The dryer shall consist of a heat exchanger, separators, hermetically sealed refrigeration unit, and self-regulating hot gas bypass valve. The dryer shall be completed with "On-Off" manual motor switch, running light, evaporator performance gauge, intake air thermometer, and automatic float-operated condensate drain trap. The dryer shall include a condenser, integral moisture separator, and a cartridge filter of the acetate fiber type, completely enclosed in an ASME pressure vessel and designed for a pressure of 150 psi (1035 kPa).

2.3.04 Piping. All interconnecting piping and tubing between components of the equipment package shall be shop installed.

Piping from the compressor discharge to the receiver shall be sized not less than the compressor discharge connection size and shall be ASTM A53, seamless, Grade B, Schedule 40 black steel pipe with ANSI B16.11, Class 3000, forged steel socket-welding fittings, or Schedule 80 black steel pipe with Class 3000 forged steel threaded fittings. "Close" nipples will not be acceptable.

Pneumatic control and instrument tubing connected directly to the compressor shall be ASTM A269, Type 304 or 316 stainless steel tubing with Parker Hannifin "CPI", Crawford "Swagelok", or approved equal, Type 316 stainless steel compression fittings. Tubing shall be not less than 1/4 inch (25 mm) OD with a wall thickness of 0.028 inch (0.71 mm).

Piping between the package receiver and the air dryer shall be ASTM B88, Type K, hard drawn copper tubing with ANSI B16.18 or B16.22 solder-joint fittings.

All piping and tubing shall be run in vertical and horizontal planes and shall not contact the baseplate. Piping shall be arranged to ensure that undue stresses from thermal expansion are not transmitted to equipment components. All control and instrument tubing shall be continuously supported.

Compressor discharge piping shall be sloped to drain to the receiver and shall include a drip trap to prevent condensate in the discharge piping from draining back to the compressor.

Drainlines from each compressor, air dryer, and receiver shall be piped to the edge of the baseplate. Receiver and air dryer drainlines shall be combined downstream of the traps.

2.3.05 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) opening galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.3.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of the equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

2.3.07 Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes.

The baseplate shall be constructed of heavy steel plate and structural members and shall be designed for not measurable deflection with the equipment mounted thereon and the baseplate supported around its perimeter. The base shall be designed so that all equipment bolted to it can be removed without access to the underside of the plate and with a flat top surface for ease of cleaning. Structural stiffeners shall be located under the compressors at the compressor anchor points. A drip lip will not be required.

2.3.08 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion
Anchors, unless otherwise indicated on the drawings.

2.3.09 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.3.10 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for coating as recommended by the paint manufacturer for the intended service, and then shop coated with one or more coats of the specified primer.

Machined and polished surfaces shall be coated with rust-preventive compound as recommended by the manufacturer.

All iron and steel surfaces, except galvanized surfaces and stainless steel, shall be thoroughly cleaned, sanded, and shop primed with one or more coats of universal primer, followed by two or more finish coats of epoxy enamel.

Galvanized surfaces shall be prepared for coating in accordance with the instructions of the primer manufacturer. Galvanized surfaces shall be shop primed with two or more coats of universal primer, followed by two or more finish coats of epoxy enamel.

Stainless steel, nonferrous metallic, and nonmetallic surfaces shall not be coated.

Epoxy enamel products for NSF certified systems shall be Ameron "Amerlock 400 High Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal. Where NSF certification is not required, the epoxy enamel products shall be Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.

The total paint dry film thickness, including prime coat and finish coats, shall be not less than 5 mils (125 µm). The color shall be safety green in accordance with ANSI Z53.1.

One quart of finish paint shall be provided with the equipment package for field touchup coating.

2.4 ACCESSORIES. Each compressed air equipment package shall be furnished with the following accessory equipment.

2.4.01 Valves.

2.4.01.01 Safety Valves. Safety valves with manual lifting levers shall be installed in the compressor discharge piping and on the receiver as indicated on the drawings. Valves in the compressor discharge piping shall be capable of protecting the compressors from damage when operating against a closed discharge valve and shall be suitable for the maximum compressor discharge air temperature.

The safety valve on the receiver shall be capable of protecting the receiver from excessive pressure.

2.4.01.02 Discharge Check Valves. A line-mounted check valve shall be provided in the discharge piping leading from the compressor. The check valves shall be sized in accordance with the manufacturer's recommendations and shall be suitable for service with reciprocating compressors at the maximum compressor discharge air temperature.

Check valves shall be disc and spring type, designed for installation in the discharge piping from reciprocating compressors, and shall be Hoerbiger "Compact-A-Check" valves, or approved equal. Combination unloading devices/check valves will not be acceptable.

2.4.01.03 Shutoff Valves. All shutoff valves shall be ball valves. Valves in steel piping shall have carbon steel bodies, chrome plated or stainless steel balls, and reinforced teflon seals and seats. Shutoff valves in stainless steel tubing shall be Type 316 stainless steel balls and reinforced teflon seals and seats. Valves in copper tubing shall have bronze bodies; chrome plated, stainless steel, or bronze balls; and reinforced teflon seals and seats. Valves in the compressor discharge piping shall be suitable for the maximum compressor discharge air temperatures.

2.4.01.04 Receiver Vent Valve. A globe type vent valve with bronze body and brass stem shall be provided on the each receiver.

2.4.02 Belts and Sheaves. All required belts and sheaves shall be furnished. Belts and sheaves shall be of the heavy-duty "V" type. Belts for each compressor shall be matched sets.

2.4.03 Intake Filter Silencers. Each compressor shall be provided with a bottom outlet, dry type intake filter silencer supported by the suction pipe and close-coupled to the compressor intake connection. Intake filter silencers shall have an outer cover and a replaceable filter element. Silencers shall be constructed of steel and shall be sized in accordance with the recommendations of the manufacturer. Sound attenuation shall be not less than 20 dB at 1,000 Hz; particle arrestance shall be not less than 99 percent at 25 micron size, and 70 percent at 5 micron size.

2.4.04 Pressure Gauges. Each pressure gauge shall have a phenol case, adjustable pointer, and stainless steel rotary geared movement. Each gauge shall be accurate to within 2 percent of full scale. Gauges shall have a minimum dial size of 4-1/2 inches (115 mm) and a range equal to approximately twice the normal operating pressure at the point of installation. The units of measurement shall be indicated on the dial face.

Panel-mounted gauges shall have a 1/4 inch (6 mm) NPT connection. All other gauges shall have a 1/2 inch (12.7 mm) NPT connection. All gauges shall be provided with a ball valve.

2.4.05 Pressure Switches. Each pressure switch shall have spdt contacts rated 10 amperes at 120 volts ac and shall be completed with shutoff valve. Pressure switches mounted inside the control panel shall have NEMA Type 1 housings.

2.4.06 Thermometers. Thermometers shall be of the remote reading mercury or gas actuated dial type. Thermometers shall have a minimum dial size of 4-1/2 inches (115 mm) and an adjustable pointer, and shall be accurate within 1 percent of full scale. Thermometers shall be furnished complete with a uniformly graduated dial indicator, armored capillary tube, bulb or temperature sensor, and thermowell. Thermometer ranges shall be such that the normal operating reading will be near the midpoint of the range. The units of measurement shall be indicated on the dial face. Spare capillary length shall be neatly coiled and tied.

Air piping shall be increased in size at the thermowell location so that the area between the well and the pipe is not less than the cross-sectional area of the original size piping. The entire sensitive length of the temperature sensor shall be installed within the airflow stream.

2.4.07 Temperature Switches. Temperature switches shall be remote bulb type with spdt contacts rated 10 amperes at 120 volts ac. Temperature switches shall have NEMA Type 1 housings, stainless steel thermowell assemblies, and armored capillaries. Capillary length shall be sufficient for mounting the switch inside the control panel. Spare capillary length shall be neatly coiled and tied.

Air piping shall be increased in size at the thermowell location so that the area between the well and the pipe is not less than the cross-sectional area of the original size piping. The entire sensitive length of the temperature sensor shall be installed within the airflow stream.

2.5 CONTROL EQUIPMENT. All control equipment for the compressor shall be furnished as necessary for a complete installation requiring only field connection of the remote alarm, and electrical power supply supplies. Equipment shall include all control switches, pressure switches, timing relays, auxiliary relays, unloaders, circuit breaker combination magnetic motor starter and other accessories required for control of the compressor. The starter shall include a thermal-magnetic circuit breaker with external operating handle and a control transformer with a 120 volt secondary, one secondary lead fused and the other grounded. Starter overload (one per phase) shall be matched to motor current and shall be provided with a "Reset" push button.

All control equipment for the compressor package, except for the high discharge temperature switches and loading controls, for the compressor, shall be housed in a control panel of NEMA Type 12 construction, mounted on the package.

All system wiring shall be shop installed to terminal blocks in the control panel. Wiring from the panel to system components shall be completely enclosed in liquid-tight flexible conduit.

All pneumatic tubing shall be shop installed to bulkhead fittings at the control panel. All field connections shall be made to the fittings at the panel.

2.5.01 Control Panel. The control panel shall be fabricated from 14 USS gage or heavier steel and shall be equipped with an approximately full-size gasketed door with chromium plated or stainless steel three-point latch and hinges. A screened vent shall be provided in the bottom of the control panel. All control devices shall be rigidly mounted within the enclosure except for breaker handles, selector switches, push buttons, and indicating lights, which shall be mounted on the panel door.

Numbered terminal blocks in the control panel and identical terminal blocks at the equipment shall be provided for those items needing field wiring between the control panel and the compressed air equipment. All items at the compressors shall be wired to terminal blocks.

Numbered bulkhead fittings at the control panel, corresponding to identical numbers at the equipment, shall be provided for all pneumatic tubing requiring field connections between the control panel and equipment. Internal panel tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipping without damage. Compression type bulkhead fittings shall be provided through the panel for all connections.

Internal panel wiring shall be neatly bundled and tied and shall be identified with suitable wire markers. Terminal blocks for external connections shall be furnished complete with marking strips, coves, and pressure connectors. A terminal shall be provided for each conductor or external circuits. All wiring shall be grouped or cabled and securely attached to the panel. Clearance for field wiring shall be provided between the terminal strips and base.

All panel equipment, wiring, and tubing shall be shop installed.

2.5.02 Compressor Control. The compressed air package shall be furnished with a control system which shall start and stop the compressors as necessary. The control system shall unload the compressors on shutdown and while coming up to speed during startup. Unloading shall be accomplished by inlet valve control.

Each compressor shall be provided with a control switch with "Lead-Off-Lag" positions. Two pressure switches with separately adjustable settings shall be furnished for the compressor, one for "Lead" and one for "Lag" control.

The control system shall start and stop the compressors at the following pressures:

Lead compressor start pressure, psig (kPa gauge)	90 (620)
Lag compressors start pressure, psig (kPa gauge)	100 (690)
Compressors stop pressure, psig (kPa gauge)	120 (830)

2.5.03 Protection Controls. A protection control system shall be provided for each compressor. The control system shall stop the compressor on high discharge air temperature.

2.5.04 Miscellaneous Controls. A dial type thermometer shall be furnished for the compressor air discharge. A package receiver pressure gauge and the compressor air discharge thermometers shall be mounted on a wing projection on top of the control panel.

White indicating lights shall be provided on the control panel to indicate the following alarm conditions:

Compressor motor overload.

High compressor discharge air temperature.

Low receiver pressure.

Indicating lights shall be heavy-duty, oiltight, semiflush type with escutcheon plates to identify the malfunction. A mechanical latching relay circuit with a common "Reset" push button shall be provided so that the alarm lights remain on until manually reset. The latching relays shall have a contact rated 10 amperes at 120 volts, which closes on alarm. An alarm light "Test" push button shall also be provided on the front of the control panel to test the lights simultaneously without actuating the remote alarm.

A normally open contact, which close under alarm conditions, shall be provided for remote alarm. The contact shall close when any alarm occurs. Contact shall be rated 10 amperes at 120 volts, 60 Hz, single phase.

The pressure switch for low receiver pressure shall have adjustable contacts set to close when the receiver pressure falls to 80 psig (550 kPa gauge).

The compressor shall be provided with an elapsed time hour meter mounted on the front of the control panel.

2.6 ELECTRIC MOTORS. Each motor shall be complete with an adjustable baseplate for mounting on the common baseplate. Motors shall be rated at 460 volts, 60 Hz, 3 phase.

Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor. Drive units shall be designed for 24 hour continuous service.

2.7 SHOP TEST. Prior to shipment, the compressor and dryer shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or wells; and proper operation of the safety and operating controls. Compressor pressure controls shall be adjusted to the specified pressures. Defective equipment and controls disclosed by such tests shall be replaced and the package placed in the satisfactory operating conditions before shipping. A statement from the package supplier certifying that the specified shop test has been performed shall be submitted to Engineer prior to shipment.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

End of Section

SECTION 15484

LABORATORY VACUUM SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers vacuum equipment serving the laboratory area, including the equipment, piping, valves, fittings, gauges, bases, anchor bolts, and other accessories and appurtenances required for a complete unit.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools, shall apply to all equipment furnished under this section.

1.2.02 Power Supply. The power supply to the equipment shall be as indicated.

1.2.03 Mechanical Identification.

1.2.03.01 Number Plates. Equipment specified herein shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Nameplates shall have black baked enamel letters on anodized aluminum plate. Number plate symbols and numbers shall be capitalized block letters with a minimum height of 3/4 inch (19 mm). Number plate height shall be twice the letter height. Number plates shall be at least 12 gage (2.66 mm) thickness. Number plates shall be installed with corrosion-resistant mechanical fasteners.

1.2.03.02 Equipment Plates. Equipment specified herein shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3 SUBMITTALS. Complete schematic and wiring diagrams, assembly and installation drawings, together with detailed specifications and data covering material used, power drive assembly, motors, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. Performance and design requirements shall be as indicated.

The approximate elevation of the site will be as indicated on the drawings. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.2 CONSTRUCTION. The vacuum system shall include, but shall not be limited to, simplex or duplex vacuum pumps as required, vacuum receiver tank, oil reclaimer, combination motor starters, control switches, piping, check valves, gauges and miscellaneous accessories to make a complete packaged unit.

2.2.01 Vacuum Pumps. Each pump shall be air-cooled, lubricated, rotary vane type and shall be driven by an electric motor mounted on the same base as the pump. The pumps and motors shall be factory mounted, wired, and piped on a horizontal receiver tank. The vacuum pumps shall be designed or equipped with a discharge exhaust filter or muffler to minimize discharge of oil to the atmosphere.

2.2.02 Receiver Tank. The receiver tank shall be horizontal type, of welded construction, with semi-ellipsoidal heads and with leg supports suitable for mounting on a concrete base. The tank shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels, shall bear the Code stamp, and the exterior shall be primed and painted with the manufacturers standard process. The tank shall have all necessary openings for inlet, discharge, drain, and gauge piping connections. A drain pipe and shutoff valve shall be provided on the bottom of the tank.

Rubber-in-shear vibration isolators shall be provided for mounting the tank to a concrete base.

2.2.03 Accessories. The unit shall be factory furnished with a vacuum gauge and vacuum switches piped to the tank. Additional vacuum system valves and miscellaneous piping and accessories shall be provided by Contractor as indicated on the drawings.

2.2.04 Controls. The vacuum pump unit shall be provided with a factory wired and installed control panel. The panel shall be rated NEMA Type 1 and shall include motor starters, vacuum switches, alternator, transformer, "TEST-OFF-AUTO" selector switches for each pump, and motor overload reset pushbuttons. The motor starters shall be combination magnetic motor starters with a magnetic motor circuit protector. Overloads shall be matched to the motors. Vacuum switches shall have a cut-out range of 5 to 25 inches Hg (16.9 to 84.6 kPa), and an adjustable differential of 4 to 12 inches Hg (13.5 to 40.6 kPa). Vacuum switch contacts shall be rated for 10 amperes at 120 volts ac.

2.2.05 Sequence of Operation. When the selector switches are placed in the "AUTO" position, the vacuum switches and alternator shall control vacuum pump operation in a start-stop or lead-lag manner, as required.

For start-stop pumps, upon a decrease in vacuum, the pump shall be energized. When the "Pump OFF" vacuum setpoint is reached, the pump shall be de-energized. Initial vacuum switch setpoints shall be as indicated in the following list:

Pump "ON"	17 inches Hg (57.5 kPa)
Pump "OFF"	21 inches Hg (71.1 kPa)

For lead-lag pumps, upon a decrease in vacuum, the lead pump shall be energized. If the vacuum continues to decrease, the lag pump shall also be energized. The lead and lag pumps shall be alternated on each cycle. Initial vacuum switch setpoints shall be as indicated below:

Lead pump "ON"	17 inches Hg (57.5 kPa)
Lag pump "ON"	15 inches Hg (50.8 kPa)
Pumps "OFF"	21 inches Hg (71.1 kPa)

2.2.06 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.

2.2.07 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of the equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

2.2.08 Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection.

2.2.09 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.2.10 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.2.11 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.3 CLEANING AND ADJUSTING. Upon completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves, and fittings shall be thoroughly washed to remove grease, metal cuttings, and dirt particles. Any stoppage or other damage caused by Contractor's failure to clean the piping system properly shall be repaired by Contractor without additional cost to Owner.

End of Section

SECTION 15486

DISTILLED WATER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers distilled water systems, including required equipment, piping, valves, fittings, gauges, bases, anchor bolts, and other accessories and appurtenances required for a complete unit. The equipment shall be installed in the laboratory as indicated on the drawings.

The distribution piping, recirculation piping, and isolating valves shall be in accordance with the piping and valve sections.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Power Supply. Except as otherwise specified, power supply to the equipment will be 480 volts, 60 Hz, 3 phase.

1.3 SUBMITTALS. Complete schematic and wiring diagrams, assembly and installation drawings, together with detailed specifications and data covering material used, power drive assembly, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance Master Specification Section 01080, Equipment, Project Submittals.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01060, Training and Operation & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Each distilled water system shall consist of one pretreatment filter, one water still, one storage tank, one circulation/distribution pump, post treatment filters, piping, and accessories normally included as part of a laboratory distilled water system.

2.1.01 Water Still. The unit shall be a classic tin lined copper and bronze still with low water cutoff, double wall evaporator, vented condenser, and a vapor baffle for pyrogen removal. The water still shall produce 5 gallons per hour (5.3 ml/s) distilled water with a minimum resistivity of 3000 Ω-m and shall be Barnstead "Model A 1015-D", or approved equal. The still shall have a fully automatic control system with an adjustable drain timer cycler. Control system shall be Barnstead "Model G2110", or approved equal. The still shall be mounted on a floorstand in the location indicated on the drawings. The still shall operate on 240 volts, 60 Hz, single phase. The solid-state low water cutoff box shall be provided with a separate 120 volt supply. Solid-state low water cutoff box shall supply power to open and close both inlet and outlet solenoid valves, shall provide terminal connections for both valves, LWCO probe, direct acting level monitor, and contactor controls. Reverse acting level monitor shall be powered from the recirculation pump motor starter CPT. The motor starter shall be provided under Master Specification Section 16050, Electrical General Requirements. Contactor for still, solid-state LWCO box, direct and reverse acting level monitors, inlet and outlet solenoid valves, and LWCO probe shall be provided by equipment manufacturer.

2.1.02 Storage Tank. The storage tank shall be copper with tin coating, 100 gallon (379 L) capacity and shall be Barnstead "Model No. B3047", or approved equal. The tank shall be provided with gauge glass, removable cover, tin-coated, draw off faucet, water inlet connection, water outlet connection, drain, pump suction connection, water seal, recirculation return connection, high and low level monitors, "Model H4005" ultraviolet lamp, low water cutoff, and "Model H3111" vent guard. The ultraviolet lamp shall be the immersion type and shall fit inside a transparent inert sheath. The lamp shall be provided with 10 "Model O4141" replacement bulbs. The tank shall be mounted on a floorstand at the location indicated on the drawings. The floorstand shall be fabricated of steel angle iron and shall be Barnstead "Model No. H1003", or approved equal.

2.1.03 Distribution/Recirculation Pump. The distribution/recirculation pump shall be 1-1/2 hp (1.12 kW), 3,450 rpm, horizontal centrifugal and shall be Barnstead Size DD Pump, "Catalog No. H1140", or approved equal, less the bypass piping. The pump shall pump to the distribution line which shall be piped back to the storage tank from the end of the distribution circuit. Pump housing and all wetted parts shall be AISI type 316 stainless steel. The pump shall be sealed with a teflon gasket, Viton O-ring and a John Crane Type 21 Viton/carbon/ceramic mechanical seal, or approved equal. The pump shall operate on 460 volts ac, 60 Hz, 3 phase. The pump shall be driven by a heavy-duty, totally enclosed, split case induction motor with ball bearing shaft supports. Included leads shall be contained in a junction box for connection to the power supply and to a low water cutoff located on the storage tank. Motor starter shall be furnished under Master Specification Section 16050, Electrical General Requirements.

2.1.04 Post Filters. Analytical grade post filters shall be installed at the locations indicated on the drawings. Each filter shall have a remote above counter mounted microprocessor controlled purity monitor and a remote above counter dispenser and shall be Barnstead "Model D4741", or approved equal with a "Model D5025" Type 1 cartridge kit, or approved equal.

Bioresearch grade, pyrogen free, post filters shall be installed at the locations indicated on the drawings. Each filter shall have a remote, above-counter mounted microprocessor controlled purity monitor and a remote above counter dispenser and shall be Barnstead "Model D4751", or approved equal with a "Model D5025" Type 1 cartridge kit, or approved equal.

2.1.05 Accessories. All accessories and appurtenances required to complete the installation of the distilled water package including all pipe, fittings, valves, cocks, gauges, and other accessories and appurtenances required to provide a workable and satisfactory installation shall be as manufactured or as recommended by the Barnstead Company, or approved equal.

2.1.06 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

2.1.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.1.08 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of a universal primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.3 CLEANING AND ADJUSTING. Upon completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves, and fittings shall be thoroughly washed to remove grease, metal cuttings, and dirt particles.

End of Section

SECTION 15487

FUEL DISPENSING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installation of fuel dispensing systems an indicated in the Contract Documents.

The fuel shall be for use in service vehicles. The fuel dispensing system shall be furnished and installed in the location and arrangement indicated on the drawings and as required, complete with fuel dispensers and all other accessories necessary for a complete and properly operating installation.

1.2 GENERAL. All equipment for this section shall be furnished by or through a single manufacturer who shall be responsible for the design, coordination, and proper installation and operation of the entire system.

Equipment furnished under this section shall be fabricated and installed in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Contractor shall properly coordinate the work between the Suppliers of equipment to be used with or connected to the storage tank to ensure that all required provisions for mounting the accessories are included.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service form other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representative shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to the equipment furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these Specifications and any state law or municipal ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

Equipment furnished under this section shall comply with the applicable requirements of the following:

> ASTM A283 "Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars," or ASTM A569 "Steel, Carbon, Hot-Rolled Sheet and Strip, Commercial Quality."
>
> American Petroleum Institute.
>
> National Fire Protection Association.
>
> Applicable local regulations and ordinances.

1.2.03 Power Supply. Power supply to equipment with motors shall be as indicated on the Contract Documents. Power supply for controls shall be as required, unless otherwise required for a properly operating system.

1.2.05 Labels. Each dispenser shall have a conspicuous, easy-to read label showing the manufacturer's name and the rated capacity.

1.2.06 Metal Thickness. Gages specified herein refer to US Standard gage.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication, assembly, and installation drawings, together with detailed specifications and data covering materials used, parts, devices, and other accessories forming a part of the tank and fuel dispensing facilities furnished, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable.

Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of each electrically operated motor driven pump, and complete details and information on the power feed system.

The data shall also indicate the sizes of all major components and full information and details concerning field assembly and installation.

The manufacturer's standard calibration charts shall be submitted.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in Master Specification Section 01060, Training, Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.4.02 Contractor's Qualification. When indicated on the Contract Documents, Contractor shall submit qualifications to do the work.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping ,handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

The tank and component parts shall be adequately protected during all transportation, loading and unloading, storage, installation, and subsequent construction activities. All nozzles shall be properly protected at all times and shall be plugged to prevent contamination of the tank interior. Repairs of minor damage, including scratches and abrasions, may be made where permitted by the Engineer in the manner recommended by the manufacturer. If a tank is damaged beyond reasonable repair, in the opinion of Engineer, it will be rejected and shall be replaced by Contractor with an undamaged unit.

At no time shall a tank be dropped or rolled. All lifting shall be done using the lifting lugs or suitable slings.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The fuel dispensing system shall be suitable for the conditions specified and the locations indicated on the drawings.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The fuel dispensing system shall be designed to supply diesel fuel or unleaded gasoline, as indicated, for refueling vehicles. The system shall be designed as a one or two hose, one or two product, as indicated in the Contract Documents.

2.3 FUEL DISPENSER. The dispenser shall be of the number of hose and product as indicated. Registers shall read on the front of dispenser with 99.9 gallon delivery register and 99,999.9 gallon nonreset totalizer. Meters shall be neutating disc-type with a calibration screw. The dispenser shall be equipped with strainer, replaceable cartridge filter, pump, electrical junction box, 1-1/2 inch suction, float chamber to prevent meter register from operating when tank is empty, and shall bear UL listing. Cabinet finish shall be baked red enamel. The pumped product shall be identified by means of a decal, painted sign, or other label. The dispenser shall be as manufactured by Fill-Rite or approved equal.

All nozzles shall be shockproof, self-closing and automatic type permitting at least three positions of the hold-open clip and shall meet all requirements required by the U.S. Environmental Protection Agency. All hose shall be 1 inch diameter, 12 feet in length, and shall be suitable for direct sunlight and air temperatures up to 100 F. Hose retrieving devices and swivels shall be installed with all hoses.

Pulsers and detect wires shall be factor installed for each hose in each dispenser, suitable to the fuel management system control console.

Fuel dispensers shall be factory wired such that they require only the specified power supply for proper operation.

2.4 FUEL DISPENSER ACCESSORIES. The accessories for each fuel dispenser shall be provided as indicated on the drawings and specified herein.

2.4.01 Pressure Regulating Valves. The inlet pipe on each dispenser shall be equipped with a 1-1/2 inch pressure regulator valve, Tokheim "Model 52", or approved equal. The pressure regulator valve shall be mounted so that the valve and inlet piping are rigidly set in position and shall be furnished with a safety shear section.

2.5 Fuel Management System. A cardless, keyless fuel management system shall be provided, installed, and placed in roper working order. Fuel management system shall be as manufactured by Fill-Rite or approved equal, shall be compatible with the dispensers provided, and with suitable relay for the pump motor. The system shall feature two wire communication, vehicle identification number entry keypad, and data retrieval by remote printer readout.

Fuel management system shall be ETL listed and consist of all items required for proper operation as specified and shall meet all local, state, and national code requirements.

The system shall provide control and access to each fueling dispenser and to store and print out, upon demand, specified data relevant to the fueling transaction. Access to the system shall be through the weatherproof terminal keypad. The terminal shall be mounted on a contractor-supplied pedestal with all required junction boxes and terminal connection clearly marked with correct wiring identification. The fuel management system supplier shall provide all wiring between the fuel management system and fuel dispensers.

The fuel management system shall control all dispensers, each with number of hoses as indicated. User access to obtain fuel shall be gained once the vehicle identification number has been manually entered onto the terminal keypad. The terminal keypad shall also incorporate battery backup to retain information in memory, in the event of a power failure or system shutoff, display operating instructions, and an RS485 port with converter cable for data retrieval.

The fuel management system shall not permit additional fueling transactions once the memory is full. The fuel management system shall be suitable for future upgrading for fleet management to be 100 percent compatible with IBM personal computer.

A parallel port Epson "Model LX300", or approved equal shall be provided to provide a hard copy audit trail of the transactions. The printer shall be located in the building. Sufficient length of interconnecting cable shall be provided to connect the terminal keypad to the printer.

Print out of the fueling transactions shall include, but not to be limited to the following items:

Vehicle Identification Number.

Transaction Termination Code.

Transaction Date.

Transaction Time.

Hose Number.

Total Volume dispensed.

Pulsers and detect wires shall be provided on dispensers. Conduits shall be provided for power and detect wires. Pulser lines may not be run in the same conduit as power lines.

System manufacturer shall warrant the system against defective materials or workmanship for two years from date of startup by factory trained personnel.

Contractor shall provide system startup and operator instruction by factory trained personnel for one day after notification that the system is in pace and ready to operate at no charge to Owner.

System to include locking emergency stop switch shall be provided to shut of the power to the dispensers in the event of an emergency.

2.6 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 INSTALLATION. Each dispenser and accessories shall be installed in accordance with the manufacturer's instructions, specifications, and drawings.

Each dispenser and accessories shall be installed on a concrete base as indicated on the drawings.

Each dispenser shall be mounted securely on a steel pump spill containment box cast in the concrete base. The pump spill containment box shall be provided with opining and an adjustable shear clamp for the inlet pipe. The pump box shall be AMFAB, shall be suitable for the dispenser, and shall be of ample size to contain spillage when maintenance is required on the pump and for piping and electrical connections.

Fuel management system terminal shall be mounted on templates with all conduits running inside template and terminal mounting pole.

3.2 INSTALLATION CHECK. An experienced, competent, and authorized representative of the manufacturer shall visit the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting appurtenances; and has been operated under full load conditions and that it operated satisfactorily.

3.3 FIELD TESTING. All testing required by governing standards shall be performed.

End of Section

SECTION 15490

HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE. These Sections and Drawings cover(s) the general requirements of the HVAC work to be performed and shall not void any of the requirements specified under the General Conditions or General Requirements.

Heating Equipment

Flue Stacks, Breechings and Vents

Air Handling Units

Centrifugal Fans

Ductwork and Accessories

Electric Automatic Temperature Control System

HVAC Systems Testing, Adjusting and Balancing

The requirements specified herein shall be modified only if specified otherwise for a particular application in other Divisions. Work to be included under the "Scope of Work" of each HVAC Section listed above shall include all labor, material, equipment, tools and services necessary to furnish, deliver, unload, install, test and place in satisfactory operation the equipment, services and systems as called for under each HVAC Section including any incidental work not shown, or not specified but which can reasonably be inferred as belonging to the various systems and necessary in good practice to provide a complete and satisfactory operating system.

This HVAC specification is incomplete without the information contained on the Drawings and in the Schedules.

Description of the work included in each Section is not intended to in any way limit the above broad statement, but is intended as a more specific mention of the most important items included therein.

Without limiting the scope of work as shown on the Drawings and required in this Section the following specific mention of items of included work is made.

The scope of work shall include: fans, air handlers, make up air units, air-conditioning units, roof mounted units, duct work by material, thermal insulation by system, acoustical insulation by system, piping by system, sting and balancing, space heaters, ductwork accessories, louvers and dampers, automatic controls by type. In addition any item that could be considered unusual shall be included.

The contractor shall coordinate with the equipment manufacturers control and field installation items furnished. The contractor shall field install and wire furnished loose by the equipment manufacturer.

All ductwork, piping, and equipment shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.2 RELATED REQUIREMENTS. Cutting coving and patching, except for items specified herein, is included in Division 1. Temporary heating, electric power and lighting is included in Division 1. Trenching, excavation and backfill except for items specified herein, is included in Division 2. Concrete work except for furnishing of required anchor bolts, sleeves and templates, which shall be furnished with equipment, is included in Division 3. Flashing and counter flashing, except for items specified herein is included in Division 7. Painting except for factory finished equipment, shop painting and identification labeling is included in Division 9. Miscellaneous metal for supplementary steel required for hangers, equipment supports, anchors and guides, which shall be furnished with equipment, is included in Division 15. Exterior louvers including installations are included in Division 10. Plumbing except water and drains in connections to HVAC equipment is included in other Sections of this Division. Electrical field power wiring except for field wiring for automatic temperature controls as specified and as shown on the HVAC Drawings is included in Division 16.

1.3 SUBMITTALS. Submit, in accordance with Section 01080, all shop drawings specified in the individual Sections. Submittals shall include the following:

Catalog data for all motors to include operating efficiency.

Catalog data on vibration isolator, including operating efficiency and layout diagram that locate the isolates on the equipment by model number. Catalog data on bearings and confirmation of bearing life for the service specified.
Information on coatings as specified in the coating section.

Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit

All submittals shall contain a statement that Section 15501 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

1.3.01 Operation and Maintenance Data and Manuals. Submit to the Engineer as provided in Section 01160, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

Contents - Each volume shall contain the following minimum contents:

Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual. Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.

Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

1.4 REFERENCE STANDARDS. The latest published issue of Standards or Recommendations of the following listed Societies, Associations or Institutes in effect 3 months prior to the date of this Contract are part of this Section. These shall be considered as minimum requirements. Specific requirements of this Section and/or Drawings shall have precedence. In case of conflict between published requirements, the Engineer shall determine which is to be followed.

Abbreviation and the title of Federal, State and industry standards, technical societies, associations and institutes and other organizations used are as follows:

AABC - Associated Air Balance Council

ACGIH - American Conference of Governmental Industrial Hygienists

ADC - Air Diffusion Council

ABMA - American Bearing Manufacturers Association

AMCA - Air Movement and Control Association ANSI - American National Standards Institute ARI - Air-Conditioning and Refrigeration Institute ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASME - American Society of Mechanical Engineers

ASTM - American Society for Testing and Materials

CTI - Cooling Tower Institute

FM - Factory Mutual Engineering and Research Corp. IBR - Institute of Boiler and Radiator Manufacturers
1IEEE - Institute of Electrical and Electronics Engineers NIST - National Institute of Standards and Technology NEBB - National Environmental Balancing Bureau
NEC - National Electrical Code

NEMA - National Electrical Manufacturers Association

NFPA - National Fire Protection Association

OSHA - Occupational Safety and Health Administration

SMACNA - Sheet Metal and Air Conditioning Contractors National Association

UL - Underwriters Laboratories

1.5 QUALITY ASSURANCE. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules
Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.

1.6 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

Instructions for the servicing and startup of equipment in long term or prolonged storage shall accompany each item.

All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.7 DEFINITIONS. Particular terminology used under this Division is defined as follows: Air Conditioning - Environmental control of temperature, humidity, cleanliness and air circulation, including the cooling of an enclosed space.

Air Conditioner or Air Conditioning Unit – One or more field-erected or factory-made assemblies, which includes the refrigeration compressor-condenser assembly, for the handling and control of air temperature, humidity, and cleanliness used for cooling.

Fan-Unit - Any unit or assembly containing a fan, motor and drive.

Temperature Controller - Any device which is used to modulate the automatic temperature control system by a change in temperature at the location of the controller.

Explosion Proof - Any equipment or device, which is called to be explosion proof, shall be certified as explosion proof as a complete unit.

1.8 COORDINATION. The Drawings indicate the extent and general arrangement of the systems. If any departures from the Drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer. The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer. The Contractor shall assume full responsibility for coordination of the HVAC systems, including; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

1.9 ENGINEERING SERVICES. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the services. The engineer shall be licensed at the time the work is done and in the State in which the project is located. If the State issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.

All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.10 ELECTRIC MOTORS. Electric motors in NEMA frame sizes shall conform to the requirements in Section 16150, unless otherwise specified herein.

Clean Dry Areas ODP

Outdoors TEFC

Process Areas

NOT Div. 1 or 2 TEFC

Div. 1 or 2 Explosion Proof.

The motor manufacturer shall confirm that motors used to power equipment are provided with bearings that will provide a bearing life equal to the driven equipment or better. Confirmation shall be included with shop drawing submittal.
Motors will be selected to be non-overloading over the entire operating range of the equipment. A safety factor of 25 percent will be added to all motors up to and including 50 horsepower. A safety factor of 15 percent will be added to all motors over 50 horsepower. Motors indicated in the schedules are to be considered a minimum. The schedule sizing is not to limit compliance with the above requirements.

1.11 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts In addition to special items, the following spare parts shall be provided:

Furnish all special tools required for normal operation and proper servicing of the equipment.

Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:

One complete set of drive belts for each piece of belt driven equipment

Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers.

Spare parts shall meet the requirements of Sections 01180.

1.12 WARRANTY. In the event that the equipment or components fail to perform satisfactorily at any time within the Defects Liability Period, the Contractor shall replace it with one capable of operating as specified, and shall comply with the requirements in Division 1. The Contractor shall be responsible for all cost incurred in furnishing and installing the replacement equipment.

PART 2 - PRODUCTS

2.1 ELECTRICAL EQUIPMENT. Certain items of electrical equipment which are furnished under this Section shall meet the requirements specified in Division 16:

Disconnect switches, motor starters and combination motor starters (starters with disconnecting means and short circuit protection) shall be as specified in Section 16050.

Cord-connected controls for hazardous areas shall be provided with intrinsically safe relays, which shall be as specified in Section 16050.

Raceways, boxes and fittings shall be as specified in Section 16050. Wires and cables shall be as specified in Section 16050.
Electrical enclosures and panels, to include automatic temperature control panels and components shall be suitable for the environment and electrical classification for the space they are located in. The type of enclosure for the various spaces shall be as specified in Division 16. Refer to the electrical drawings for the space classifications.

Where location designations are not shown on the HVAC Drawings refer to the Electrical Drawings

2.2 EQUIPMENT VIBRATION ISOLATORS AND MOUNTINGS. Unless otherwise specified in this Division all machinery or vibrating mechanical equipment shall be isolated from the building structure by vibration isolators with a minimum deflection as specified. Operating equipment that can transmit objectionable vibration and noise must be installed with special types of vibration isolators such as flexible connectors to ductwork, piping and wiring. In more critical areas and under particular conditions, additional vibration isolators shall be installed as specified in other related Sections in this Division, or in specific equipment schedules.

All equipment shall be provided with attachment points for floor or suspended mounting that will safely transmit all loads to the supports.

The vibration isolator manufacturer shall be responsible for the proper selection of vibration isolators suitable for the particular application. Selection of the vibration isolator shall include the following factors:

Equipment Weight

Equipment operating frequencies

Type of building support structure

Vibration isolators shall be furnished with the equipment.

All floor mounted vibration isolators shall be bolted to the floor or framing on which they rest. Bolts shall be arranged to prevent transmission of vibration through the bolts.
All isolation devices for a single piece of equipment shall be selected for a uniform static deflection according to distribution of weight in the equipment.

All pieces of equipment that have a variation in weight during operation or maintenance such as, but not limited to, cooling towers and hoppers, shall have built-in vertical limit restraints to limit motion to a maximum of 1/4-in.

Isolators exposed to the weather, in rooms classified on electrical drawings as damp, wet, or corrosive or where called for on the Drawings shall be provided with corrosion protection. Steel parts other than springs shall be galvanized. Parts subject to wear, rubbing, shall be non-corrosive material such as rubber or stainless steel. Springs and hardware shall be cadmium plated or otherwise provided with an approved coating.

After installation of equipment, isolators shall be adjusted for proper loading and distribution of weight.

Types - The following types of vibration isolators may be used.

Isolation Types for Floor Mounting

Single elastomer-in-shear isolators, molded mound shaped element designed for 1/4-in deflection under the imposed static load. Double elastomer-in-shear isolators shall be two such elements assembled in series or a molded element designed to provide 1/2-in deflection under the imposed static load. Elastomer-in-shear isolators shall be properly housed to prevent bulging and shall be provided with adequate facilities for bolting to equipment and floor slab.

Spring isolators shall be free standing and laterally stable and shall be equipped with acoustical-friction pads, leveling bolts and bolt holes for anchoring to floor slab. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection. Where housed springs are specified or required, provide units with telescoping cast iron or steel housing, containing one or more springs, complete with resilient alignment insert and a minimum of 1/4-in thick rubber or neoprene sound deadening pad bonded to the base of housing.

Heavy load pads shall be 1-1/4-in thick and shall consist of a high load capacity elastomer pad and sandwiched between two 1/8-in thick steel load distribution plates capable of supporting loads up to 250 psi. For large pad area, steel plates of suitable thickness shall be provided to distribute the load.

Light load pads shall be neoprene corrugated single, laminated double or laminated with 1/2-in thick fine granular composition cork sandwiched between two 1/4-in layers of corrugated, oil resistant neoprene. Pads shall be capable of loading to 50 psi.

Isolation for Suspension

Isolation hangers for suspension of equipment and piping shall have a single element of elastomer for 1/4-in deflection, a double or a single molded element of 1/2-in deflection, a single spring element with an elastomer grommet for up to 3/4-in deflection and a combination of an elastomer and spring elements in series for 1-in deflection and up contained within a structural rigid one piece steel hanger box. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection.

The neoprene element shall have a bushing to prevent hanger rod contact with the housing box. The lower rod shall be free to swing in a 30 degree arc without touching the spring or the housing.

Rails and Bases - Rails and bases shall be of the following types based on the equipment and deflection required.

Rubber in shear type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall incorporate single or double deflection elastomer-in-shear fastened in place and a continuous steel floor bearing plate running the full length of each rail. The rails shall be drilled and tapped to accept the supported equipment and shall serve as a template.

Steel spring type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall consist of structural members supported by individual free standing springs. The rails shall be drilled to accept the supported equipment and shall serve as a template.

Fans and their driving motors shall be mounted on structural steel channel members forming a rigid base. A common member, parallel to the V-belt drive, shall run the full length of the fan and motor and shall be of sufficient rigidity to resist the bending stress of belt pull. The structural steel base shall incorporate single or double deflection elastomer-in-shear elements or free standing springs located for proper weight distribution. The base shall be drilled and tapped to accept the fan and motor and shall serve as a template. Integral motor slide rails shall be provided and welded in place.

Unless specifically noted in other Sections or on specific equipment schedules, all equipment will be provided with vibration isolation as defined by the following table:

Type of Equipment	Vibration Isolation Type	Minimum Deflection for Slab on Grade Inches	Minimum Deflection for up to 20-ft floor span inches	Minimum Deflection for 20-ft to 30-ft Floor Span Inches	Minimum Deflection for 30-ft to 40-ft Floor Span Inches
Axial & Cabinet Fans					
22-in dia. and less	Rubber	0.25	--	--	--
22-in dia. and less	Spring	--	0.75	0.75	0.75
Over 22-in dia. Over 2-in S.P.	Spring	0.75	1.75	1.75	2.50

Type of Equipment	Vibration Isolation Type	Minimum Deflection for Slab on Grade Inches	Minimum Deflection for up to 20-ft floor span inches	Minimum Deflection for 20-ft to 30-ft Floor Span Inches	Minimum Deflection for 30-ft to 40-ft Floor Span Inches
Centrifugal Fan					
22-in dia. and less	Rubber	0.25	--	--	--
22-in dia. and less	Spring	--	0.75	0.75	1.75
24-in dia. and greater					
40 HP and less	Spring	0.75	0.75	0.75	1.75
50 HP and greater	Spring	1.00	1.75	1.75	2.50
Condensing Units					
	Rubber	0.25	--	--	--

	Spring	--	0.75	1.75	1.75
Air Handling Units					
10 HP and less	Spring	0.75	0.75	0.75	0.75
15 HP and greater	Spring	0.75	1.75	1.75	1.75

Isolation for Piping

Flexible piping for systems with operating temperatures over 200 degrees F shall be flexible annular corrugated stainless steel hose. The hose shall be provided with an external stainless steel braid to minimize elongation under pressure. Hoses 2-1/2-in and smaller shall be threaded and hoses 3-in and larger shall be flanged. The manufacturer shall confirm the suitability of the flexible piping for the temperature and pressure of the systems.

Flexible piping for systems with operating temperatures 200 degrees F and less shall be spherical EPDM connections. Connections shall have multiple plies of corded fabric reinforcing. Connection shall be rated for 150 psi at 220 degrees F. For equipment with connections from 2-1/2 to 12-in, 90 degree bend connections can be used. Straight connections shall be double sphere and bend connections shall be single sphere. Provide control cables to prevent excessive elongation on straight connection where required. The manufacturer shall confirm the suitability of the connections for the temperature, pressure, and pipe contents for the systems.

Rigidly Mounted Equipment

When equipment doesn't require vibration isolation, it shall be firmly attached to the building structure. Bolts and support structure shall include allowances for seismic loads as required by the applicable building codes to include shear and moment loads.

2.3 BEARINGS. Grease lubricated bearings (except where driven by motors smaller than 1/2 Hp) shall be equipped with Zerk lubrication fittings and with provision for automatic relief of lubricant pressure away from fan wheel or pump seal. The latter may be accomplished by either built-in relief devices or automatic ball-and-spring relief fittings at the bottom of the bearing housing.

Pressure relieves shall be located outside of the units and shall be visible from maintenance locations. Lubrication fittings shall be located to be easily accessible from maintenance or operating levels. Where necessary, extension tubes shall be provided to bring the service fitting to an accessible location and the relief visible from the same location.

Bearings for all equipment in the schedule below shall have heavy-duty grease lubricated ball or roller bearings. Bearings shall have ample thrust provision to prevent end play during the normal life of the bearing. Unless specifically noted otherwise, all fans and pumps shall have bearings for both the equipment and motors with the following ABMA L-10 life.

Fans over 3000 cfm – 40,000 hours.

Continuous duty fans with motors over 25 horse power 100,000 hours.

For systems with bearings requiring L-10 lives of 100,000 hours or greater, the equipment supplier shall provide calculations for both the equipment bearings and the motor bearings to confirm the bearing selections. For belt drives, the calculations shall include the effect of the sheave size, number of belts, the sheave location on the shaft, and the location of the motor to the driven sheave.

The equipment manufacturer shall provide confirmation of the required life based on the actual drive components. For motors 50 horsepower and greater, the bearing life calculations for both the equipment bearings and the motor bearings shall be provided.

2.4 <u>FLAME AND SMOKE RATINGS</u>. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the Federal Standard 00136B, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA.

These requirements shall apply to all circumstances whether the materials are field applied or have been applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project for installation.

2.5 <u>V-BELT DRIVE</u>. V-belt drives shall consist of the driver and driven sheaves and one or multiple matched V-belts. Drives furnished to transmit less than 3/4 Hp may be a single groove, single belt type. Drives to transmit 3/4 Hp or more shall consist of at least two belts. Belts smaller than "A" cross-section shall not be used.

Each sheave shall be grooved to match the belt selection, bored and keyed to fit the receiving shaft, and grooves shall be in parallel planes exactly perpendicular to the bore for the full 360 degrees. Sheaves shall have keys and setscrews. Sheave material may be cast iron.

The drive shall be sized 1.5 times the motor nameplate rating and also shall have ample strength to start the driven equipment by full voltage across-the-line motor starting.

Where variable speed drive is specified, the drive sheave shall be of the variable pitch type which will provide a 5 percent speed variation of the driven equipment at the nominal rated speed. However, the higher speed side shall not cause the driven equipment to draw more than full nameplate rating horsepower from the driver.

2.6 NOISE CRITERIA. The selection of fans, air handling equipment, air conditioners, heating ventilating and air conditioning machinery and mechanical equipment and the installation of the system components such as duct work and piping shall be such as not to exceed to maximum permissible noise for non-equipment spaces as defined in Table 2, Design Guidelines for HVAC System Noise in Unoccupied Spaces contained in the 2003 edition of the ASHRAE Application Handbook. Under no conditions shall the noise created by equipment exceed the levels of permissible noise exposures of occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances.

The equipment supplier shall provide actual data for the equipment submitted. If the space does not meet the required criteria, and the noise level of the equipment is found to be the cause, the equipment supplier shall be responsible for the modifications required to correct the condition.

PART 3 – EXECUTION

3.1 INSTALLATION. The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

3.2 CLEANING AND DISINFECTION. All piping, ductwork and equipment shall be left in a thoroughly cleaned condition. All piping shall be thoroughly flushed to remove all foreign materials prior to any cleaning procedure. All strainer baskets shall be removed, cleaned and reinstalled at the completion of the cleaning operation and also at the completion of all system and equipment final tests. All flushing and cleaning shall be to the satisfaction of the Engineer. Furnish, install and remove all temporary piping and equipment used in the cleaning and flushing operations. Cleaning and flushing shall be performed as specified in other Sections.

3.3 TESTS AND BALANCING. General - Balance and test all systems. Test the work as required by the Engineer during the progress of the work to demonstrate the strength durability and fitness of the installation. Furnish all instruments, ladders, lubricants, test equipment and personnel required for the tests; including manufacturer's representatives for testing and start-up of all supplied equipment.

Balancing and testing shall be performed as specified in other Sections. Before testing and balancing, all systems shall be cleaned and disinfected as specified. Four copies of records of all tests, measurements, settings of throttling devices and nameplate data shall be presented to the Engineer.

Final Tests - Tests of all systems shall be carried out as required by the Engineer prior to final acceptance of the systems for the purpose of demonstrating satisfactory functional and operating efficiency as well as adjustment. During this period, the setting of all automatic controls shall be checked and sufficient measurements taken to ensure that conditions are correct and that capacities are adequate to meet the specified requirements. Provide competent personnel to conduct all tests. Systems will not be considered complete until all tests have been concluded to the satisfaction of the Engineer and all other parties having jurisdiction. In event of leakage or defects, tests must be repeated until all faults are corrected. All tests shall be performed in the presence of the Engineer. The general operating tests shall be performed under as near design conditions as possible.

Testing and balancing of all heating, ventilating and air conditioning air and water systems shall be performed by an AABC or NEBB certified agency, which is independent of all suppliers and installers on the particular job. All testing, adjusting and balancing shall be done under the supervision of a qualified heating, ventilating, and air conditioning Engineer employed by the air balance and testing agency. Reporting forms for testing and balancing shall be as recommended by the AABC or the NEBB.

3.4 START-UP AND TEMPORARY OPERATION. Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner.

This maintenance shall include compliance with the manufacturers operating and maintenance instructions as well as periodic checking and cleaning of the strainers and filters and the lubrication of moving parts and all required adjustments.

Records of all maintenance and lubrication work performed on Owner or Contractor furnished equipment shall be maintained at the construction or installation site and shall be available at all times for a review by the Owner or Engineer. At the request of the Owner or Engineer copies of these records shall be submitted to the Owner for information and/or review.

3.5 PAINTING AND COATINGS. Unless otherwise specified, all machinery and factory finished equipment such as fans, air handling units, air conditioning units, and other items of manufacture shall be hot dipped galvanized or will have a factory applied finish, color as standard with the manufacturer. Components fabricated from stainless steel do not require a coating finish unless otherwise specified. All tanks, supporting steel, hangers, rods and all other uncoated or non-galvanized steel other than standard piping and fittings shall have a shop coat consisting of a suitable primer and finish coat. If not factory applied, the prime coat shall be as specified in Division 9. All items not factory or shop primed prior to installation shall be suitably cleaned of rust and mill scale by wire brushing, sanding, or other means and prime painted, immediately after installation.

The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufactures coatings and shall ensure that the materials used for such repair shall match and be compatible with the manufacturer's standard color, coatings and practices. Surfaces to be repaired or recoated are to be prepared as recommended by the paint or coating supplier. Care shall be taken not to paint over nameplates.

Furnish touch up paint for the various types of equipment furnished and deliver unopened paint to the Owner at completion of the project. The amount of touch-up paint supplied shall be sufficient to cover 15 percent of the applicable painted surfaces or one pint, whichever is greater.

Where specified, or called for on the following schedule, special corrosion resistant/protective coatings shall be provided. Whenever a protective coating is specified, the equipment shall be coated both inside and out. Whenever necessary to provide full coverage of the equipment, the equipment shall be completely disassembled to allow proper preparation and coating application. Any component that would block the coating process shall be removed. Equipment provided with gaskets or liners shall be coated before the application of the gasketing or liner. The equipment Vendor shall test rotating equipment after coating to confirm dynamic balance. If work needs to be done to correct the equipment balance, the integrity of the coating must be corrected after such work.

Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.

All items to be provided with a protective coating shall have the following data on the coating included with the unit submittal. Submittal shall include vendor data sheets on the specific coating being used, corrosion resistance data sheets, detailed application data sheets to include surface preparation procedures. For baked coatings submit a letter from the coating manufacturer, that the company doing the actual coating operation is an approved coating company. When an equipment supplier provides the coating, the information shall be supplied by the coating manufacturers.

Coating shall be factory applied by the equipment manufacturer/supplier. If this is not possible, coating shall be applied by a specialty shop under contract to the equipment manufacturer/ supplier. After coating application is completed, the equipment manufacturer/supplier shall test the equipment and certify system operation prior to releasing the equipment to the job site.

Any holidays, runs, sags, blisters, or inclusions in the coating are unacceptable and will be corrected. With the approval of the Engineer, small areas no more than 4-in by 4-in may be corrected in the field. Larger faults shall be returned to the coater to be repaired. The faulty material shall be removed by sanding and in the case of blisters, the edges feathered. The material used for recoating shall be manufactured by the same manufacturer as the original coating and shall be suitable for field repairs. The touch up material shall have the same corrosion resistance as the original coating, and if the original coating required an ultraviolet protection, the same protection will be provided as part of the repair. The final mil thickness of the repaired coating shall be equal to the originally specified thickness. Where baked coatings have been damaged, the repair shall be made with heat applied to the repaired surface to cure the coating. After curing a solvent test as recommended by the manufacturer shall be used to confirm that the coating is cured.

3.6 BALANCE OF ROTATING EQUIPMENT. All machines shall be balanced both statically and dynamically by the manufacturer within the limits of best commercial practices. The term machine, as used above, is to be considered as any piece of equipment which contains rotating components. All machines furnished shall have operating speed not exceeding 80 percent of the first critical speed.

End of Section

SECTION 15500

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heating, ventilating, and air conditioning (HVAC) equipment, coils, fans, ductwork, duct mounted devices, and appurtenances associated with the HVAC systems.

Schedules on drawings and notes indicate specific HVAC equipment required for the project.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, unless otherwise indicated on the drawings.

Capacity ratings for packaged air conditioning units and packaged heat pumps with capacities less than 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 210/240. For packaged air conditioning units over 135,000 BTUH (39 kW) the capacity ratings shall be in accordance with ARI Standard 360. Capacity ratings for packaged heat pumps with capacities over 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 340.

Flue piping and fittings shall be factory built, laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211.

Electric heating coils shall comply with the current National Electrical Code.

Direct fired makeup air units shall be independently certified to meet ANSI Z83.4.

Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the drawings, and shall be UL listed.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, ductwork, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/4 inch (19mm) high for section identity and 1/8 inch (3 mm) high for other information Nameplates and tags shall be at least 12 gage (2.66 mm) thickness. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.3.05 Ductwork. As required, ductwork shall be identified with nameplates as specified herein, or stenciled painting as specified in Master Specification Section 09900, Painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Packaged Air Conditioning Units/Packaged Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Makeup Air Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Burner or heating coil capacities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Fans

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Schematic control wiring diagrams showing multiline wiring for the unit and all interconnecting devices. Wiring diagrams shall be detailed to the degree required for field construction, with all terminals identified.

Equipment

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Sheet Metal Fabrication Drawings

Duct layout drawings indicating shop fabricated sections and dimensions.

Pressure and seal classifications.

Access panel and door construction, sizes, and locations.

Duct sealant, adhesive, gasket, and tape information.

Coatings.

Ductwork materials.

Coatings

Name of manufacturer.

Coating type.

Chemical resistance data.

Temperature range data.

Surface preparation and application data.

Film thickness per coat.

Drying and curing time.

Color.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower (kW) rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

Temperature Controls

Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the drawings.

Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring and instrument piping with all terminals and ports accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

Control valve schedule with each valve identified by the designations used herein and on the drawings and cross-referenced to the manufacturer's equipment data sheet or bulletin. The schedule shall also list complete sizing data for each valve, giving design flow and temperature or pressure, actual pressure drop, normal position, fluid, actual close-off rating, actual capacity index, and any other pertinent data.

Sequence of operation for each system corresponding to the control schematics.

Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

Space thermostat schedule indicating the types of covers and means of adjustment for each space.

Conduit and wire types.

Number Plates

A listing of equipment to receive number plates.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4.03 Samples. Samples of protective coatings for equipment shall be submitted to Engineer for approval. The samples shall be at least 3 inches by 3 inches (75mm by 75mm) in size, and shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. Extra materials for one complete change of lubricating oil and two sets of filters shall be furnished for the equipment.

Extra materials shall be packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as required.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be indicated in Master Specification Section 09900, Painting.

Machined, polished and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.08 Flue Systems. Flues shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Flue system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions.

2.4.08.01 Factory Built Flues. Flue systems for gravity vented equipment and vertically vented unit heaters listed for use with "Type B" gas vents shall be Selkirk Metalbestos, "Type B" gas vents, Metal-Fab, or approved equal. The flue systems for power vented equipment shall be Selkirk Metalbestos "Type PS" gas vent, Metal-Fab "Model PIC", or approved equal.

The flue pipe and fittings for vertically power vented unit heaters requiring a 5 inch (125 mm) or smaller flue and gravity vented equipment shall be a "Type B" gas vent. The flue shall be of double wall construction, with a 0.25 inch (6 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch (0.3 mm) aluminum and the outer jacket of at least 0.018 inch (0.5 mm) galvanized steel. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

The flue pipe and fittings for power vented equipment and power vented unit heaters requiring a 6 inch (150 mm) or larger flue shall be of double wall construction with a nominal 1 inch (25 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch (0.9 mm) AISI Type 304 or Type 316 stainless steel, as required, and the outer jacket of at least 0.025 inch (0.6 mm) aluminum coated steel for interior locations and Type 304 or AISI Type 316 stainless steel, as required, for the portions of the stack exposed to the outdoor environment. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

2.4.08.02 Metal Flues. The flue pipe and fittings for horizontally power vented unit heaters requiring a 5 inch (125 mm) or smaller flue shall be constructed of at least 24 gage (0.61 mm) thickness galvanized steel and shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The flue system shall include all necessary fittings, hangers, supports, and flashings.

2.4.09 Packaged Air Conditioning /Heat Pump Units. Packaged air conditioning units, denoted by the symbol "PAC" and an identifying number, and packaged heat pumps denoted by the symbol "PHP" and an identifying number shall be furnished and installed where indicated on the drawings. Each unit shall be designed for outdoor installation on a full perimeter curb or equipment pad as indicated on the drawings. The packaged air conditioning unit shall be manufactured by Trane, Carrier, McQuay, York, or approved equal.

2.4.09.01 <u>Performance and Design Requirements</u>. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with Refrigerant-22 and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated. The unit shall be suitable for the power supply and shall have the capacities indicated on the drawings.

The refrigeration system shall be capable of satisfactory operation at outdoor ambient air temperatures of 50°F (10°C) in the cooling mode and for heat pumps, 0°F (-18°C) in the heating mode. When the system must operate in the cooling mode at a lower temperature than the factory standard, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F (-18°C) consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

2.4.09.02 <u>Casing</u>. The unit casing shall be of weatherproof design and shall be constructed of 20 gage (0.91 mm) or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have one inch (25mm) thick, one pound (454 kg) density, insulation coated on the air side. Aluminum foil-faced glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed access doors or removable panels shall be provided to permit easy inspection and maintenance. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

Where an economizer package is not specified, a manually set air damper shall be furnished to provide the indicated outside air volume.

2.4.09.03 <u>Indoor Coil Section</u>. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig (1380 kPa gauge). The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions.

2.4.09.04 Heating Sections. When indicated on the drawings, the unit shall have an electric heating coil, gas heating section, or auxiliary electric heating coil. Electric heater coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the drawings.

Gas-fired heating sections shall be completely factory assembled and wired integral within the unit. When located upstream of the cooling coil, the heating section shall be AGA design certified specifically for outdoor applications upstream of a refrigerant cooling coil. The heat exchanger shall be of constructed of minimum 20 gage (0.91mm) aluminized steel. The burner shall be induced or forced draft type with pressure regulator, redundant main gas valve, manual shutoff valve, and intermittent spark ignition. A flame sensing device and high limit safety controls shall be provided. The number of heating stages shall be as indicated in the schedules on the drawings.

The unit shall be supplied with natural gas having a calorific value of approximately 1000 Btu per cubic foot (37 MJ/m^3) at an inlet pressure as indicated.

2.4.09.05 Filters. Filters shall be mounted integral within the packaged air conditioning or heat pump unit and shall be 2 inches (50 mm) thick. Hinged access doors shall be provided. Filters shall conform to the requirements in the Air Filtration Equipment paragraph. Filters shall be washable and reusable.

2.4.09.06 Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons (17.5 kW) and smaller shall have direct or belt driven fans. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons (17.5 kW) shall have V-belt drive with adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Motors and Motor Controls paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the drawings are external to the complete unit. Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column (0.087 kPa) shall be used for 2 inch (50 mm) pleated filter losses.

The outdoor fans shall be direct drive, vertical discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2.4.09.07 Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning or heat pump unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2.4.09.08. Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoors coils, expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, refrigerant piping, and a full operating charge of refrigerant. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, compressor, and refrigerant charge. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

2.4.09.09 Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak and pressure tested. The coils shall be protected with hail guards.

2.4.09.10 Accessories. Where indicated on the drawings, the packaged unit shall be provided with economizer cycle to automatically utilize up to 100 percent of outside air for cooling. The economizer shall be controlled as required, and shall modulate return and outside air dampers to maintain proper discharge temperature into the conditioned space. The dampers shall be equipped with automatic lockout when the outside air temperature is too high for proper cooling, and shall have adjustable minimum position control. The damper motor shall be spring return and shall operate to close the outside damper during shutdown. Means for 100 percent relief of the return air shall be provided.

Where indicated on the drawings, hot gas bypass shall be installed to provide reduced capacity control.

When indicated, packaged units shall be furnished with a roof mounting curb. The curb shall be constructed of at least 16 gage (1.52 mm) zinc-coated steel with nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply and return air openings. The curb shall be a minimum of 16 inches (405 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.4.09.11 Controls. Each packaged unit shall be completely factory wired and shall have a single point power connection and unit mounted disconnect switch. All wiring shall be installed in accordance with the National Electrical Code.

The unit shall be provided with remote control and monitoring panel consisting of system operation switches and signal lights. The signal lights shall be for power, outage, dirty filters, and reset relay.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal volt control power transformer.

Defrost controls, electronic timed initiated and temperature terminated with field adjustable timer shall be provided for all packaged heat pumps. When auxiliary electric heating is provided, a factory installed emergency heat package shall be provided. When heating is locked out, the auxiliary heat shall be activated as necessary.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the drawings.

The thermostat shall be a manual changeover, automatic changeover, or programmable heating and cooling type. The number of stages shall be suitable for the unit control and operation. The thermostat shall have a range of approximately 50 to 90°F (10 to 32°C) with at least a 5°F (3°C) deadband between heating and cooling. The thermostat shall have a subbase to control system and fan operation.

2.4.10 Makeup Air Units. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be Hastings "SBD", Hartzell "GMC", Engineered Air "Series HE", or approved equal for direct fired units and Hastings "Counterflo", Engineered Air "Series DJ", or approved equal for indirect fired units as indicated in the schedules on the drawings. The makeup air units shall be constant volume, gas-fired type, and shall be completely assembled, wired, and flame tested at the factory.

Where indicated in the schedules on the drawings, makeup air units shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.4.10.01 Construction. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, a gas-fired burner section, a filter section, and, when located outdoors, an inlet hood with motorized control damper. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed and hinged doors shall be furnished to provide access to all internal components. An observation port shall be provided on the burner section for viewing the pilot and main flames.

The burner section shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density foil-faced fiberglass blanket insulation securely fastened to the panels. The fan and accessory sections shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density mat-faced cleanable fiberglass blanket insulation securely fastened to the panels. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. The insulation shall meet the requirements of NFPA.

Makeup air units installed outdoors shall be of weatherproof construction, with roof panels pitched for drainage. The roof panels shall be constructed with triple-break seams which overlap the side panels on all sides. All exterior joints shall be bolted or screwed with a gasket, or shall be welded, and shall be sealed weather tight.

Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air shall be mounted on the unit inlet. The hood shall include a two-positioned motorized control damper which opens when the unit is energized and closes when it is de-engerized.

2.4.10.02 Fan Section. The makeup air units shall be equipped with centrifugal fans with forward-curved blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with motors greater than 15 horsepower (11.2 kW) and permanently lubricated or grease lubricated for units with 15 horsepower (11.2 kW) motors and smaller. Units with regreasable bearings shall have externally mounted, grease lubricated bearings or lubrication fittings extended to the exterior fan casing with aluminum or copper tubing and grease fittings rigidly attached to the casing.

Static pressure values indicated in the schedules are external to the complete unit. Internal burner or heat exchanger, filter, and fan housing losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for filter losses.

2.4.10.03 Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors and controls shall be as specified in the Electrical paragraph.

Makeup air units with smaller than 10 horsepower (7.5 kW) motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower (7.5 kW) and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.

2.4.10.04 Heating Section. The complete fuel burning assembly shall conform to the requirements of UL/ETL, FM, or IRI. The burner assembly and gas piping arrangement shall include, but not be limited to, pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valves, and electric modulating main gas valves. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment.

The unit shall be suitable for use with the gas pressure range as indicated.

2.4.10.04.01 Direct Fired. Burners shall be in-line type, suitable for use with natural or propane gas, as required, and shall be complete with stainless steel firing plates, cast iron gas feed, and stainless steel side plates for flame rods and ignition spark rods mounted in ceramic isolated bushings. The profile plates shall be adjustable and shall be sized to maintain the required velocity across the burner. The burners shall be capable of modulating turndown of 20 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff.

2.4.10.04.02 Indirect Fired. Burners shall be modulating power type suitable for use with natural or propane gas, as required. The burners shall be capable of modulating turndown of at least 8 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff. The heat exchanger shall be of 3 or 4 pass design consisting of 400 series stainless steel primary drum heat exchanger with multitube secondary heat exchanger.

2.4.10.05 Filter Section. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute (1.5 m/s) at design conditions unless otherwise indicated in the schedules on the drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch (50 mm) pleated type and shall conform to the Air Filters paragraph. All filters shall be washable and reusable.

2.4.10.06 Controls. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, an electronic discharge air temperature sensor and controller, and a disconnect switch. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the drawings. The controls shall include controls to lock out the burner when the outside air temperature is above the controller setpoint.

A remote control station shall be furnished with the makeup air unit and located where indicated on the drawings. The control station shall allow for remote operation of the unit with a fan "On-Off" switch, a "Winter-Summer" switch, a supply temperature setpoint adjustment, and indicating lights for fan, heat, lockout, and dirty filters. Where indicated in the sequence of operations, a room override thermostat shall be mounted on the panel.

Unit mounted panels shall house adequately sized combination starters rated in accordance with NEMA standards, and dead-front 3 lock nonfused disconnect switches.

2.4.10.07 Accessories. Makeup air units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage (1.90 mm) thickness zinc-coated steel with a nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply air opening as indicated on the drawings. The curb shall be a minimum of 16 inches (400 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.4.11 Heaters. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2.4.11.01 Electric Duct Heaters. Electric duct heaters, denoted by the symbol "EDH" and an identifying number, shall be manufactured by Indeeco, Brasch, or approved equal.

Electric duct heaters shall be furnished and installed where indicated on the drawings.

Electric duct heaters shall be open coil or finned tube, as required, and zero clearance type with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames with 2 inch (50 mm) wide flanges suitable for fastening to the ductwork.

Bushings for open coils shall be ceramic and terminals shall be stainless steel. Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

Heaters shall be completely factory wired and shall be provided with disconnecting backup and safety contactors, transformers, an automatic reset thermal cutout, a manual reset thermal cutout, a disconnect switch, and a differential pressure airflow switch. All interconnecting wiring shall be enclosed in a terminal box fastened to the heaters and oriented as indicated on the drawings. The terminal boxes shall be furnished with double doors.

Contactors shall be 600 volt rated, 3 pole, UL listed, and shall have a life expectancy for 100,000 operations. A built-in industrial dry type 480/120 volt control transformer shall be furnished to carry the full contactor holding coil load. Transformer primary and secondary windings shall be fused. Secondary windings shall have one lead grounded.

The duct heaters shall be furnished with a silicone controlled rectifier (SCR) control unit mounted in the duct heater terminal box. The control unit shall be suitable for the temperature range of 32 to 132°F (0 to 55°C), and shall be a solid-state proportioning controller designed to modulate the heater output from 0 to 100 percent. The duct heaters shall be controlled by a thermostat as indicated on the drawings. The duct heater SCR controller shall be compatible with the signal from the thermostats.

The duct heater output in kW shall be as specified at 460 volts, 60 Hz, 3 phase. The heater elements shall be suitable for operation on 480 volt, 60 Hz, 3 phase power.

2.4.11.02 Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the drawings.

Electric Unit Heaters (non-explosionproof). Electric unit heaters located in unclassified areas shall be Chromalox "LUH" or "VUH", Brasch, or approved equal. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the drawings to be wall hung, a wall mounting bracket shall be provided.

Electric Unit Heaters (explosionproof). Where indicated in the heater schedule on the drawings to be explosionproof, unit heaters shall be manufactured by Indeeco "Ultra-Safe", Ruffneck, Markel, or approved equal. Explosionproof electric unit heaters shall be of the fan forced type with a heat exchanger, fan and motor assembly, automatic reset thermal cutout, built-in contactor, factory installed three pole disconnect switch in NEMA 7 enclosure, and 24 volt control transformer. The heater shall be suitable for use with the power supply indicated in the heater schedule on the drawings. The heater shall be listed for installation in a Class I, Division 1 or 2, Group D location and shall have an NEC ignition code of T3B or better.

The heater cabinets shall be constructed of a corrosion resistant cabinet fabricated from an epoxy coated 14 gage (1.90 mm) thickness steel with individually adjustable outlet blades. Cabinet fasteners shall be stainless steel.

The heat exchanger shall be an efficient liquid to air design utilizing a copper or steel core with aluminum fins. The heat exchanger shall be provided with a coating suitable for use in a corrosive atmosphere consisting of hydrogen sulfide. The heating elements shall be housed in an inhibited propylene or ethylene-glycol heat transfer fluid that is suitable for temperatures down to -49°F (-45°C). A pressure relief valve shall provide overpressure protection for the heat exchanger.

The fan and motor assembly shall consist of an aluminum fan connected to a explosionproof, permanently lubricated ball bearing type motor with built-in thermal overload protection. The motor shall be prewired to the control enclosure providing for a heater that is suitable for use with a single point power connection.

2.4.11.03 Gas Unit Heaters. Gas unit heaters, denoted by the symbol "GUH" and an identifying number, shall be Modine Model HS, Reznor, Trane, Sterling, or approved equal.

Gas unit heaters shall be furnished and installed where indicated on the drawings. Each heater shall be of the type, size, and capacity indicated in the schedules on the drawings; shall be suitable for use with the gas type and pressure as required; and shall be of a type approved and listed in the AGA Directory of Approved Gas Appliances and Accessories.

Each gas-fired unit heater shall be power vented, horizontal discharge, propeller type, and suitable for two point suspending mounting. The heater burner and heat exchanger shall be constructed of E-3 (AISI Type 409) stainless steel. Each heater shall be furnished with a vent cap.

Each gas unit heater shall be furnished complete with a 24 volt transformer, single-stage gas control with a regulated combination redundant gas valve, a spark-ignited, intermittent safety pilot with electronic flame supervision and all required limit and safety controls. Units larger than 125,000 Btu (132,000 kJ) input shall have two-stage gas controls.

The fan motor shall be suitable for use with a 120 volt, 60 Hz, single phase power supply, and shall be provided with automatic reset thermal overload protection.

2.4.11.04 Wall Heaters. Wall heaters, denoted by the symbol "WH" and an identifying number, shall be manufactured by Electromode "Model EWA", Brasch, or approved equal.

Wall heaters shall be downflow type; designed for surface mounting; and shall include an electric heating element, a thermal limit switch, a fan delay switch, a fan and motor assembly, and a built-in thermostat. The heaters shall be suitable for use with the specified power supply and shall have the capacity indicated in the schedules on the drawings.

2.4.12 Fans. Each fan shall be complete with an electric motor, a drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower (7.5 kW) motors and fixed sheaves for 10 horsepower (7.5 kW) and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

Fan drive motors and controls shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the drawings.

Fans indicated in the schedules on the drawings to be explosionproof shall be suitable for installation in a NEC Class I, Division 2, Group D environment.

The external static pressure values indicated in the schedules on the drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for pleated filter losses.

A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp (0.4 kW) to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

Where indicated in the schedules on the drawings, fans shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.4.12.01 Cabinet Fans. Cabinet fans, denoted by the symbol "CF" and an identifying number, shall be Greenheck "Model SP" or “Model CSP”, Penn Ventilator, Loren Cook, or approved equal. Cabinet fans shall have steel, forward-curved, squirrel-cage type wheels. The fans shall be statically and dynamically balanced. Motors shall be open dripproof, PSC, with permanently lubricated ball bearings and internal thermal overload protection, and shall be suitable for use with the power supply indicated in the schedules on the drawings. Fan housings shall be fabricated of heavy gage carbon steel with welded seams and shall be acoustically lined and factory primed. Fans shall be installed in the configuration indicated on the drawings. A removable access panel or exhaust grille shall be provided on the bottom of each fan and a factory installed backdraft damper shall be provided on the fan discharge. Vibration isolator units and wall caps shall be provided for each fan as indicated in the schedules on the drawings.

2.4.12.02 Duct In-Line Fans. Duct fans, denoted by the symbol "DF" and an identifying number, shall be Greenheck "SQ", Penn Ventilator, Loren Cook, or approved equal. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.

The fan housing shall be square, constructed of aluminum or heavy gage steel as required, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch (25 mm) fiberglass duct liner.

Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, permanently sealed pillow block bearings.

Flexible wiring leads shall be provided from the fan motor to an external junction box and disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

2.4.12.03 Duct Axial Fans. Duct axial fans, denoted by DAF and an identifying number, shall be Hartzell, Greenheck, Penn Ventilator, Loren cook, or approved equal. The model and type (fiberglass or stainless steel) of each fan is per Fan Schedule shown on the Drawings. Duct axial fans shall be of the axial belt drive type fan built to be installed in duct systems for process ventilation applications, and where the nature of the corrosive airstream warrants isolation of the motor and drive assembly from the airstream.

The fan housing shall be round, constructed of fiberglass or heavy gage stainless steel as required, and shall be furnished with duct mounting collars. Vibration isolation units shall be provided for each installed fan.

Motor and drives shall be isolated from the air stream. The six-blade propeller shaft shall be stainless steel construction, mounted in heavy duty self-aligning bearings.

2.4.12.04 Power Roof Ventilators. Power roof ventilators, denoted by the symbol "PRV" and an identifying number, shall be Greenheck "G" or "GB", Penn Ventilator "Domex", Loren Cook, or approved equal.

Power roof ventilators shall be centrifugal or propeller type, as indicated in the schedules on the drawings, and shall be statically and dynamically balanced for quiet, vibration-free operation. Each fan shall be complete with a weather hood, a safety disconnect switch mounted in the hood, a 1/2 inch (13 mm) mesh aluminum bird screen over all openings, and, where indicated in the schedules on the drawings, a backdraft damper. Fan housings shall be constructed of aluminum and shall have an aluminum base of the self-flashing type, suitable for mounting on the curbs indicated on the drawings.

2.4.12.05 Propeller Fans. Propeller fans, denoted by the symbol "PF" and an identifying number, shall be Greenheck "Model S" or "Model SC" for direct drive and "Model SB" or "Model SBC" for belt drive, Penn Ventilator, Loren Cook, or approved equal.

Propeller fans shall consist of a panel frame, a wire guard, a motor, and fan blades. Fan blades shall be steel or aluminum, as required. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.

When indicated in the schedules on the drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, backdraft damper, and weather hood with birdscreen.

2.4.12.06 Utility Fans. Utility fans, denoted by the symbol "UF" and an identifying number, shall be Greenheck "Model SWB", Penn Ventilator, Loren Cook, or approved equal.

Utility fans shall be multiblade, squirrel-cage type, with nonoverloading type blades. The fans shall be statically and dynamically balanced for quiet, vibration-free operation and shall be provided with vibration isolators. Fan inlets and outlets shall be provided with removable angles and bolts for attaching flexible connections. Fan housings shall be heavy gage steel, of all-welded construction and shall be shop coated with universal primer. Fan bearings shall be of the self-aligning, ball type.

2.4.12.07 Wall Fans. Wall fans, denoted by the symbol "WF" and an identifying number, shall be Greenheck "Model GW" or "Model GWB", Penn Ventilator, Loren Cook, or approved equal. Wall fans shall be suitable for sidewall installation; shall be direct or belt driven, centrifugal type, with aluminum wheels and housing, and a wheel guard located on the discharge side; and shall be statically and dynamically balanced at the factory. The fan motors shall be of adequate size to prevent overloading when operating at the specified capacity and shall be suitable for use with the power supply indicated in the schedules on the drawings.

2.4.12.08 Vault Supply Fans. Vault supply fans shall be in-line centrifugal type fiberglass construction, belt driven with removable fiberglass motor guard. Units shall be furnished with integral flanges and straightening vanes. Fan shaft shall be stainless steel construction with Viton seals. Bearing to be sealed pillow block type. Refer to drawings and fan equipment schedule for additional information.

2.4.13 Roof Hoods. Roof hoods, denoted by the symbol "RH" and an identifying number, shall be Greenheck "Model FHI" or "FHR", Penn Ventilator, Loren Cook, or approved equal.

Roof hoods shall be suitable for air intake or exhaust and shall have throat dimensions as indicated in the schedules on the drawings. As required, the roof hood assembly shall be constructed of galvanized steel or aluminum. Each roof hood shall be complete with a weather hood, a 1/2 inch (13 mm) mesh aluminum or galvanized bird screen over all openings, and a mounting base suitable for installation on a curb as indicated on the drawings.

Where indicated in the schedules on the drawings, roof hoods shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.4.14 Dampers.

2.4.14.01 Backdraft Dampers. Backdraft dampers, denoted by the symbol "BDD", shall be Arrow United Industries "Type 655", Ruskin, or approved equal. Backdraft dampers shall be constructed with a 1 by 4 inch by 0.081 inch thick (25 by 100 mm by 2 mm) extruded aluminum frame. Blades shall be of 0.081 inch (2 mm) aluminum, with silicone rubber seals on the edges, and with aluminum shafts and ball bearings.

2.4.14.02 Control Dampers. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet (2.3 m^2) or with any dimension exceeding 48 inches (1200 mm) shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit.

Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

Control dampers shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.4.14.02.01 Duct Mounted Control Dampers. Control dampers and face bypass dampers mounted in ductwork and equipment curbs shall be Ruskin "CD-50", Arrow United Industries "Type AFD-20", or approved equal. The damper frames shall be constructed of 5 inch (125 mm) Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch (150 mm) wide airfoil-shaped extruded aluminum.

Control dampers denoted on the drawings to be face and bypass dampers shall be vertically arranged. The face damper dimensions shall be coordinated with the heating coil dimensions. The bypass area shall be half the area of the face damper. Face and bypass damper submittals shall indicate coil size, face dimensions, and bypass dimensions.

2.4.14.02.02 Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Ruskin "CD-40", Arrow United Industries "Type AFD-20", or approved equal. Control damper frames shall be constructed of 4 by 1 inch (100 by 25 mm) 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch (100 mm) wide airfoil-shaped extruded aluminum.

2.4.14.02.03 Round Control Dampers. Round control dampers shall be Arrow United Industries "Type 70, 75, or 80", or approved equal. The damper frames and blades shall be constructed of the material as required.

2.4.14.03 Volume Control Dampers. Volume control dampers shall be denoted by the symbol "VCD". Volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD", Ruskin “Model MDRS25” , or approved equal. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770", Ruskin “Model MD35” , or approved equal.

Rectangular volume control dampers shall be fabricated of 16 gage (1.52 mm) thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch (100 mm or 125 mm by 25 mm) channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch (178 mm) long, 22 gage (0.76 mm) thickness frame, and a minimum 20 gage (0.91 mm) thickness circular blade.

The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

2.4.14.04 Fire Dampers. Fire dampers, denoted by the symbol “FD”, installed in positions having a fire resistance rating of less than 3 hours shall be Air Balance Inc. “Model D19”, Ruskin “Model DIBD2”, or approved equal. Fire dampers installed in partitions having a fire resistance rating of 3 hours or more shall be Air Balance Inc. “Model D30”, Ruskin “Model DIBD23”, or approved equal. Fire dampers shall be style “B” for ducted and style “A” for non-ducted applications unless otherwise indicated on the Drawings.

Dampers shall have a 5 inch (125mm) side galvanized steel channel frame, galvanized steel interlocking blades, stainless steel closure springs and latches, 165°F (74°C) fusible links, and a 20 gage (0.91 mm) thickness galvanized steel housing. Factory fabricated sleeves and mounting angles shall be furnished for each damper for mounting as indicated on the Drawings. Fire dampers shall be rated in accordance with UL-555 for use in dynamic systems.

2.4.15 Damper Operators. The damper operators shall be direct coupled or linkage type. Where linkage type operators are used, each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

Each operator shall have sufficient torque to operate the connected control damper area. Each damper operator shall have at least a 50 inch-pound (5.6 N-m) normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators shall be furnished to produce the normal running torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the drawings. Face dampers shall fail to the closed position and bypass dampers to the open position.

Where damper operators are installed in explosionproof rated areas indicated on the drawings, the operators shall be furnished and installed in explosionproof housings suitable for installation in an NEC Class I, Division 2, Group D area. Where damper operators are installed outdoors, the operators shall be furnished and installed in weathertight enclosures.

Two-position direct coupled electric damper operators shall be Belimo "NF120-S", Honeywell "ML4195", Johnson Controls, or approved equal. Linkage type electric damper operators shall be Honeywell "Model M4185", Johnson Controls "Model M100", or approved equal. Two-position electric damper operators in hazardous areas shall be installed in explosion proof housings.

Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA Type 1 enclosure fastened to the motor housing.

Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable. The operators shall be suitable for direct mounting to shafts up to 1 inch (25 mm) and shall be complete with mounting brackets and damper position indicator.

Linkage type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch (9.5 mm) square, double-ended drive shaft.

2.4.16 Air Outlet and Inlet Devices. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, Titus, or approved equal. Air outlet and inlet devices shall be furnished and installed where indicated on the drawings.

Air outlet and inlet devices shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.4.16.01 Ceiling Diffusers. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the drawings. Size, location, and direction of airflow shall be as indicated on the drawings.

2.4.16.02 Registers and Grilles. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

2.4.17 Flexible Connections. Flexible connections located indoors shall be Ventfabrics "Ventglas", or approved equal. Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon", or approved equal.

Ductwork connections to the air handling equipment, and where indicated on the drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches (76 mm) of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20 to 180°F (-29 to 82°C) and shall weigh at least 27 ounces per square yard (915 g/m^2).

Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10 to 250°F (-23 to 121°C) and shall weigh at least 24 ounces per square yard (814 g/m^2).

2.4.18 Air Filtration Equipment.

2.4.18.01 Pleated Air Filters. Pleated air filters shall be American Air Filter "AM-AIR 300X", Farr "30/30", or approved equal. Filters shall be washable and reusable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have an average efficiency of 25 to 30 percent based on the ASHRAE 52.1 test method.

One inch (25 mm) filters shall have at least 14 pleats per linear foot (0.3 m) and at least 1.9 square feet of media per square foot of filter area (1.9 square meters per square meter). One inch (25 mm) filters shall have a maximum initial resistance of 0.10 inch wc at 300 feet per minute (0.02 kPa at 1.5 m/s).

Two inch (50 mm) filters shall have at least 12 pleats per linear foot (0.3 m) and at least 4.2 square feet of media per square foot of filter area. (4.2 square meters per square meter). Two inch (50 mm) filters shall have a maximum initial resistance of 0.13 inch wc at 300 feet per minute (0.03 kPa at 1.5 m/s).

2.4.18.02 Side Access Filter Housings. Side access filter housings shall be American Air Filter "Access Air", Farr "Model 4P Glide/Pack", or approved equal. Side access filter housings shall be single-stage, factory-fabricated of 16 gage (1.52 mm) thickness galvanized steel and shall be equipped with flanges for connection to the ductwork. Access doors shall be 16 gage (1.52 mm) thickness galvanized steel and shall be positioned to allow replacement of filters from either side of the housing. Filter housings and doors shall be insulated and of double-wall construction. Filter tracks shall be provided to accommodate nominal 2 inch (51 mm) thick washable and reusable filters as described herein. Leakage at the rated airflow shall be less than 1 percent at a 3 inch wc (0.75 kPa) differential.

2.4.19 Draft Gauges. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge", or approved equal.

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch (89 mm) diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140°F (-7 to 60°C), and a range of 0 to 1.0 inch wc (0.25 kPa), with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves.

2.4.20 Sheet Metal Work. The ductwork, accessories, bracing, and supports shall be constructed of the material as required. Galvanized ductwork located in air conditioned spaces shall be constructed of G-60 or better lockforming quality in accordance with ASTM A653. All other galvanized ductwork shall be constructed of G-90 or better galvanized steel. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Plenums shall be constructed of reinforced 16 gage (1.52 mm) thickness galvanized sheet metal.

Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch (25 mm).

Sheet metal fan boxes shall be fabricated with 12 gage (2.66 mm) thickness galvanized sheet metal skin and structural steel framing of sufficient strength to support the fan box and the fan mounted on the box. The framing shall be coated with a universal primer. All welds on galvanized metal shall be cleaned and coated with a zinc-rich paint. Drawings of the fan boxes shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

Where indicated on the drawings, ductwork and accessories shall be given a protective coating resistant to the corrosive atmosphere.

2.4.21 Duct Insulation. Interior duct liner shall be Knauf "Duct Liner E M", CertainTeed "ToughGard R", Schuller "Permacote-Linacoustic", or approved equal.

Interior duct liner shall be 1-1/2 pound per cubic foot (24 kg/m^3) density, spray coated duct liner with an "R" value of at least 3.6 $ft^2 \cdot hr \cdot$ °F/BTU (0.63 $m^2 \cdot$ °C/W) per 1 inch (25 mm) thickness. The insulation shall be suitable for temperatures up to 250°F (121°C) and shall have at least a 0.55 NRC per 1 inch (25 mm) thickness. The insulation shall conform to ASTM C1071.

2.4.22 Flexible Duct and Takeoffs. Flexible duct shall be Flexmaster "Type 9", Flexible Technologies "Thermaflex Type G-KM", or approved equal. Takeoffs shall be Buckley Air Products "Air-Tite Bellmouth BM-D", or approved equal.

Flexible duct shall be a galvanized or vinyl-coated spring steel helix, bonded to a polymer liner, and wrapped with glass fiber insulation suitable for use in heating and cooling systems. The insulation shall provide an "R" value of at least 4.2 $ft^2 \cdot hr \cdot$ °F/BTU (0.74 $m^2 \cdot$ °C/W). The outer jacket shall be a vapor barrier of fire retardant polyethelene or polyolefin material. The flexible duct shall be listed under UL 181 as Class 1 flexible air duct and shall comply with the latest edition of NFPA 90A.

Takeoffs for the flexible duct shall be bellmouth type manufactured of galvanized steel with a neoprene gasket and predrilled holes. Each takeoff shall be equipped with a balance damper constructed of 26 gage (0.45 mm) thickness galvanized steel. Scoops or other obstructions in the main duct will not be acceptable.

2.4.23 Access Doors. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2.4.24 Temperature Controls. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; Siemens Building Technologies, Landis Division, or approved equal. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2.4.24.01 Performance and Design Requirements. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. Where cable and conduit is not indicated on the drawings but is needed for a complete and functional control system in accordance with the sequence of operation it shall be provided as specified herein. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation.

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper actuators, thermostats, temperature control panels, pressure differential switches, control switches, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the Electric Wiring paragraph. Cable and conduit for all HVAC power circuits shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.4.24.02 Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ± 2°F (1.1°C), and the relative humidity within ± 5 percent of the setpoint.

2.4.24.03 Thermostats.

Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", Siemens Building Technologies, or approved equal.

Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 3.5°F (2°C). The thermostats shall have a spdt switch rated for 1 horsepower (0.746 kW).

Low Limit Thermostats. Low limit thermostats shall be Honeywell "L480", Penn Controls "Model A11A-1", Siemens Building Technologies, or approved equal.

Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet (6 m) long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35°F to 45°F (2°C to 7°C), and shall be manually reset.

Modulating Duct Mounted Thermostats. Modulating, duct mounted thermostats shall be Honeywell "Model T991", Penn Controls "Model A80ABA-2", Siemens Building Technologies, or approved equal.

Modulating, duct mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have a range of approximately 10°F to 90°F (-12°C to 32°C) with an adjustable throttling range of approximately 5°F to 24°F (3°C to 13°C), and shall be furnished with a duct mounting kit.

Explosion-proof Thermostats. Explosion-proof wall-mounted thermostats controlling explosion-proof equipment in Class I, Division 2, Group D areas shall be Honeywell "Model T6051B", Johnson Controls, Siemens Building Technologies, or approved equal.

Duct-mounted thermostats controlling explosion-proof equipment in Class I, Division 2, Group D areas shall be Indeeco "Model T94A-70".

Explosion-proof thermostats shall be suitable for installation in explosion-proof areas.

2.4.24.04 Temperature Control Panels. Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be NEMA Type 12 designed for wall mounting and shall be completely prewired and checked. Temperature control panel enclosures shall be manufactured by Hoffman Engineering, Integration Technology Systems Inc, Par Metal Products Inc, or approved equal.

All electrical accessory devices and internal wiring shall be furnished and installed.

All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm and indicating lights, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel. Accessories such as indicating lights and selector switches shall be mounted on the front hinged covers of the panels. The accessories shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panel with corrosion-resistant pan head screws.

Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, and smoke detectors. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operation on the drawings.

All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame resistant covering rated for at least 90°C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Wiring for secondary power distribution and for control, annunciator, and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the legend on the panel wiring diagrams.

Selector Switches. Selector switches shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Selector switches shall be heavy-duty oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.

Push Buttons. Push buttons shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

Indicating Lights. Indicating lights shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Alarm, indicator, and running status lights shall be furnished with bulbs. Indicating lights shall be heavy-duty, push-to-test, oiltight type with low voltage bulbs and built-in transformers. Legends shall be engraved on the lens or on a legend faceplate. Bulbs shall be easily replaceable from the front of the device.

Alarm Horns. Alarm horns shall be Federal Signal "Model 350", or approved equal. Alarm horns shall have a sound output of 100 dB at 10 feet (3 m) and shall be rated for 120 volts ac. Horns shall be furnished with mounting hardware suitable for flush mounting.

Relays. Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; Struthers-Dunn "Series A3, A4", or approved equal. Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or engraved switch settings marked in seconds and shall have timing repeatability of ± 2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

Terminal Blocks and Panel Wiring. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.

A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches (200 mm) of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.

All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts.

Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of the depth of the duct available for future use after the installation including all field wiring, has been completed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

Where signal wiring must be routed to more than one panel or device, the requested circuit routing shall be as indicated on the electrical one-line diagrams.

Control Power Transformers. Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.

Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils (100 μm). One quart (0.95 L) of paint shall be furnished with the panels for future touchup painting.

2.4.24.05 Temperature Indicators.

2.4.24.05.01 Dial Thermometers. A dial thermometer shall be supplied and installed at each remote bulb sensor for calibration and calibration checks. The range of the dial thermometers shall be -40°F to 120°F (-40°C to 49°C).

In ducted systems containing coils or electric duct heaters, a dial thermometer shall be furnished and installed on the downstream side of the coil or heater. Thermometers shall be complete with averaging type elements.

2.4.24.06 Smoke Detectors. Smoke detectors, denoted by the symbol "SMD" and an identifying number, shall be System Sensor “DH100”, Simplex, Grinnell, or approved equal.

Detectors shall be designed to detect combustion gases, fire, and smoke in air conditioning and ventilating duct systems in compliance with the NFPA 90A and shall contain a detector and air sampling chamber which serves as a reference point to help stabilize the detector against the effects of changes in temperature, humidity, and pressure.

Smoke detectors shall be duct mounted photoelectric type and shall be completely self-contained, including integral power supply, supervisory and control circuitry and three sets of isolated contacts. The alarm contacts shall be spst normally open; the auxiliary alarm contact shall be spdt, and the trouble contact shall be spdt and shall indicated detector malfunction. The alarm and trouble contacts shall be rated 2 amperes at 30 volts dc. The auxiliary alarm contact shall be rated 10 amperes at 120 volts ac. Pilot lights shall be provided for visual indication of alarm and power supply status on the front of the unit. A remote key-operated test station with alarm light and power supply status shall also be furnished and installed where indicated on the drawings. Detectors shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply.

Detectors shall be provided with sampling tubes extending the width of the air duct.

2.4.24.07 Pressure Differential Switches. The pressure differential switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Initial setpoints shall be as indicated on the drawings. Differential switches shall be UL listed.

Where indicated on the drawings, pressure differential switches shall be provided with an explosion-proof housing suitable for a NEC Class 1, Division 2, Group D environment. Where differential pressure switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided.

2.4.24.07.01 Airflow Switches. Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800", or approved equal. Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spst, shall be rated 5 amperes at 120 volts ac and for a temperature range of -20°F to 125°F (-29°C to 52°C), and shall be provided with corrosion resistant mounting brackets. Pressure differential switches located across filters shall be initially set at 0.5 inch wc (125 Pa).

2.4.24.08 Control Stations. Control stations for high rate ventilation fans shall include a two position selector switch with nameplate labeled "High Rate Ventilation On/Off". Control stations shall also include two indicating lights for "On/Off" indication. Indicating lights and selector switches shall be heavy duty oiltight NEMA

Type 13. The control station enclosure shall be NEMA Type 4. Control stations shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.4.24.09 Emergency Ventilation Shutoff Switches. Emergency ventilation shutoff switches shall be double-action manual fire alarm stations. The switches shall be Simplex "Series 2099", or approved equal. The switch operation shall require that a hammer, hung on the front of the station, be lifted and thrown downward against the glass window, thus breaking it to expose the recessed pull lever. The switches shall be provided with phenolic nameplates identifying the switches as "VENTILATION SYSTEM EMERGENCY SHUTOFF". The nameplates shall cover the words "FIRE ALARM" on the switches. Switches located on the exterior of the building shall be provided with a weather protective shield.

2.4.24.10 Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2.4.24.11 Electrical Wiring. Detailed wiring diagrams shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.

Control wiring shall be in accordance with the National Electric Code (NEC). Cable shall be multi-conductor, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations.

Conduit for all HVAC control circuits shall be EMT, except in areas designated on the electrical drawings as Area Type 1A, Area Type 4, or Area Type 12. In areas designated Type 1A, conduit shall be exposed rigid PVC non-metallic conduit with PVC fittings, boxes, and accessories. In areas designated Type 4 and Type 12, conduit shall be IMC with gasketed enclosures and fittings. All conduit and conduit installation shall be in accordance with the requirements of Master Specification Section 16050, Electrical General Requirements and NEC.

2.4.25 Electrical. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.4.26 Drive Units. Drive units shall be designed for 24 hour continuous service.

2.4.26.01 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor.

2.4.26.02 Safety Guards. All belt drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.4.26.03 Electric Motors. Motors furnished with equipment shall meet the following requirements.

A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feed and chemical handling locations.

4. Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor’S option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase. Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

Motors to be used with adjustable frequency drives shall be rated for inverted service.

2.4.27 Shop Testing. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

2.4.28 Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3.2.02 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Flues. Flues for all equipment exhausting combustible material shall be installed where indicated on the drawings. Flue gas systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

Flues shall be supported where indicated on the drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the flue systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

The flue height dimensions indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

All vertical flues shall be equipped with a capped tee to serve as a condensate drain. Flues 6 inches (150 mm) and larger shall be equipped with a condensate drain connection.

When power vented equipment is listed as being suitable for use with "Type B" gas vents, "Type B" gas vents may be used when all vent joints are sealed to prevent leakage.

Where metal flues are used, each joint shall be sealed with sealant and/or aluminum or teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Where single wall metal flues are used to vent equipment, a double wall flue shall be used outside and shall extend through the wall a minimum of 6 inches (150 mm). The annular space of the double wall flue shall be sealed at the connection point between the double and single wall flues. Single wall flues routed through unconditioned spaces or in locations below 8 feet (2.4 m) above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150°F (65°C).

Gas unit heater flues shall be installed with a minimum of 12 inches (300 mm) of straight pipe attached to the venter outlet before the installation of an elbow.

3.3.02 Packaged Air Conditioning Units/Packaged Heat Pumps. The packaged air conditioning units and packaged heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the drawings.

3.3.03 Makeup Air Units. Flexible connections shall not be in tension when the fans are operating.

3.3.04 Heaters. The bottom elevation of unit heaters shall be 8 feet (2.4 m) above finished floor unless otherwise indicated.

Gas fired unit heaters with side burner and control access shall have the access located on heater side opposite the wall.

Electric duct heaters shall be installed with a minimum distance of 4 feet (1.2 m) from all ductwork transitions and obstructions on both sides of the heater.

3.3.05 Fans. Flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

Power roof ventilators shall be secured with corrosion resistant lag screws to the roof curb.

3.3.06 Roof Hoods. Roof hoods shall be secured with corrosion resistant lag screws to the roof curb.

3.3.07 Damper Operators. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position, face dampers shall fail to the closed position, and bypass dampers to the open position.

3.3.08 Air Outlet and Inlet Devices. Diffusers with balance dampers installed in the flexible duct takeoffs shall not have an opposed blade damper mounted in the throat of the diffuser.

Ceiling mounted air terminals or services weighing 20 pounds (89 N) shall be supported directly from the structure.

3.3.09 Draft Gauges. Draft gauges for filters located more than 8 feet (2.4 m) above the finished floor shall be mounted on the nearest wall, 5.5 feet (1.7 m) above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

3.3.10 Sheet Metal Work. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards. The locations, arrangement, and sizes of ductwork shall be as indicated on the drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

Ductwork shall be constructed and installed in accordance with the drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet (2.4 m) above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch (200 mm) lighting allowance between the ceiling and the bottom of the ductwork.

In vertical ducts with a closed bottom which terminate less than 24 inches (600 mm) above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch (12.5 mm) drain hole in the bottom of the duct.

Single-thickness turning vanes shall be installed in all turns with 45 degree or greater angles.

3.3.11 Duct Insulation. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces which are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.

Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches (200 mm) on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

The following ducts shall be insulated with a one inch (25 mm) thick interior duct liner unless otherwise indicated or indicated on the drawings to be wrapped:

Makeup or outside air ducts.

Air conditioning system supply and return ducts.

Other ducts where indicated on the drawings.

3.3.12 Flexible Duct and Takeoffs. The length of the flexible ductwork shall not exceed 8 feet (2.4 m). All support saddles for flexible duct shall be a minimum of 6 inches (150 mm) wide.

3.3.13 Access Doors. Airtight access doors shall be provided for inspection of all control dampers, fire dampers, smoke dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches (200 mm) square for hand access, 18 inches (450 mm) for shoulder access, or as indicated on the drawings. Each access door shall be installed to open against the pressure in the duct.

3.3.14 Temperature Controls. Automatic temperature controls shall be furnished and installed as indicated on the drawings and as specified herein.

Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the drawings. Control equipment shall be installed with adequate space for operating and maintenance access.

3.3.14.01 Temperature Control Panels. The panels shall be mounted so that selector switches and indicating lights on the panel are located approximately 5 feet (1.5 m) above the finished floor.

3.3.14.02 Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in Master Specification Section 16050, Electrical General Requirements. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3.14.03 Device Tag Numbering System. All field mounted control devices shall be identified with an identification plate as described in the Equipment Identification paragraph securely fastened to the device. The device identification shall agree with those listed on the drawings. Hand-lettered or tape labels will not be acceptable.

Identification plates for thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the device identification list the controlled equipment in parenthesis below the device number.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15510

HEATING BOILERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heating system boilers and associated devices and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

When required, each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Equipment Motors

Name of manufacturer.

Type and model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Bearing types and numbers.

Weight.

Overall dimensions.

Full load amperes, efficiency, and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Data and Manuals. When required, operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

Flue piping and fittings shall be factory built, laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211.

Gas fired boilers shall be rated in accordance with the provisions of the American Gas Association, shall have AGA certified input and gross output ratings, and shall be listed by I-B-R. The gas fired boilers and control components shall be tested in accordance with ANSI Z21.13b. All electrical safety controls shall be of accepted quality and shall be UL and AGA certified. Each boiler shall be constructed in accordance with Section IV of the ASME Boiler and Pressure Vessel Code, shall be stamped with the official ASME symbol, and shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. As required, extra materials shall be furnished for the equipment.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules. Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as required.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as required.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 GAS-FIRED HEATING WATER BOILERS. Gas fired heating water boilers, denoted by the symbol "HWB" and an identifying number, shall be Weil-McLain, Peerless, or approved equal. The boiler model shall be as required.

The boiler shall be furnished complete with a burner assembly, firing controls, control panel, fuel valve gas trains, electrical wiring, safety equipment, a structural steel base, and all accessories and appurtenances specified or required for a complete, properly operating installation.

2.5.01 Performance and Design Requirements. The boiler shall be listed by I-B-R, shall be designed for the I-B-R capacities indicated in the schedule on the drawings, and shall be capable of developing the full I-B-R listed output at 100 percent firing rate. The heating water boiler shall be stamped for the maximum working pressure as required.

2.5.02 Boiler Construction. The boiler shall be a factory assembled package, atmospheric or forced draft burner type as required, low pressure, wet base design, cast iron, sectional type.

Where the boiler physical size precludes the use of a packaged unit and with the written concurrence of Engineer, a field assembled unit will be acceptable. To minimize field assembly work, major components shall be shop assembled to the maximum extent practicable.

The boilers shall be designed for vertical travel of flue gas. Each section of the boiler shall be manufactured with cast-on heat absorbing studs to achieve efficient and rapid heat transfer from the combustion gases to the boiler water. Boiler sections shall be fabricated with ground-faced metal-to-metal joints which do not need putty, cement, or other filler.

Each boiler shall be equipped with access openings for cleaning the flueways between sections.

The boilers shall be provided with a built-in air elimination system to ensure positive separation of air from circulating water. The boilers shall be constructed to provide balanced water flow through the entire boiler. Forced draft boilers shall be designed and constructed so that the combustion chamber is completely surrounded by circulating water.

The boiler sections shall be furnished with a flue collector hood and horizontal to vertical draft hood constructed of heavy gage aluminized steel. The flue collector hood shall be securely bolted to the top of the boiler sections. A gastight seal shall be maintained between the flue collector hood and the top of the boiler sections.

The boilers shall be furnished with insulated heavy gage steel jackets with baked enamel finish and insulated with heavy density fiberglass on the left and right ends, top, back, and interior panels. The jackets shall be designed for installation after the supply and return piping have been connected and shall be easily removable.

Observation ports shall be mounted on the front and back sections of the boiler to permit visual inspection of the burner flame.

The boiler end sections shall be provided with suitable tappings for connection of supply and return piping and controls.

2.5.03 Burner Assembly. The boiler shall be furnished with and designed for use with the burner type and fuel gas type as required.

The atmospheric type main burners shall be aluminized steel of one-piece construction suitable for high flame temperature, quiet ignition and extinction, and reliable flame retention. The burners shall be designed so the proper amount of primary combustion air will be drawn into the burner throat entry over a range of burner manifold gas pressures as required.

The forced draft type burner shall be modulating, low fire start, power gas type, designed to burn the type of fuel as required without vibration, noise, or pulsations. The burner shall incorporate a stainless steel flame retention type combustion head and shall be equipped with an external primary-secondary air ratio adjustment and total air volume adjustment. A permanent observation port shall be provided to allow observation of both pilot and main flames. The burner shall be equipped with a forced draft air fan sized to supply the air required for proper combustion of the specified fuel. The unit shall be equipped with an airflow switch to shut off the fuel supply upon failure of the combustion air.

The complete fuel burning assembly shall conform to the requirements of the UL, FM, or the IRI as required. The fuel train shall consist of pressure regulators, shutoff valves, gas valves, high and low gas pressure switches, and vent valves. The fuel train piping shall include 1/4 inch (6 mm) pressure tappings with pipe plugs upstream and downstream from each valve and regulator.

2.5.04 Boiler Trim. The boilers shall be furnished with combination pressure-temperature gauges to indicate boiler water temperature and system pressure. The combination gauges shall be of rugged, guarded type construction with clearly marked and easy to read dials.

Each boiler shall be furnished with a relief valve. The relief valve shall be of the side outlet discharge type, shall be ASME certified, and shall be set to relieve at the rated boiler ASME working pressure. The valve shall have a discharge capacity equal to or greater than the listed I-B-R gross output of the boiler.

A stack thermometer shall be furnished with each boiler for installation in the boiler vent.

2.5.05 Controls. Burner controls shall be provided for control of the fuel supply to the burner and pilot. The gas control components shall be located outside the boiler jacket for easy access, adjustment, and servicing. The automatic safety pilot system shall provide 100 percent shutoff.

Electronic flame rectification controls and intermittent electric ignition pilot systems shall be provided for each boiler. The safety pilot shall be intermittent burning, electrically ignited, and electronically supervised. In the event of flame failure, the controls shall automatically interrupt the fuel supply to the pilot and burner, sound an audible alarm, and light a visual indicator. After shutdown caused by flame failure, the burner shall have to be manually restarted.

Controls shall provide at least a 30 second pre-purge of the combustion chamber before ignition of the fuel and a 15 second or longer post-purge after interruption of the fuel supply.

The boilers shall be furnished with operating, high temperature, and low water cut-off controls. The operating controller shall be set to maintain the temperature of the water leaving the boiler. The high limit control shall be set at least 20°F (11°C) higher than the design leaving water temperature. The low water cut-off control shall be manually reset and shall automatically prevent boiler operation when the boiler water level falls below the safe limit.

The controls shall include automatic spark ignition and provisions for automatic restarting after a power failure or momentary interruption of the fuel supply.

2.5.06 Control Panel. The boiler controls shall be mounted on an electrical control panel which shall include a circuit breaker for 480 volt, 60 Hz, 3 phase power supply, a forced draft blower motor starter for forced draft type burners, burner firing controls, an ignition transformer, an alarm bell, and all electrical controls and devices specified herein or otherwise required for proper operation of the equipment.

All controls shall be housed in NEMA Type 1 enclosures. All external wiring shall be enclosed in conduit.

All electrical components shall be factory-installed and wired so that only connection of the power supply circuit to the control panel is required during installation of the equipment. A control power transformer for the load of all accessory devices listed in the Sequence of Operations shall be included to supply 120 volt control power.

The boiler control panel shall include an isolated contact for use with the temperature control system to indicate boiler trouble. The contact shall close in the event boiler operation is interrupted by flame failure, low water cutoff, or limit control.

2.6 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.7 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.7.01 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.7.02 Electric Motors. Motors furnished with equipment shall meet the following requirements unless otherwise specified in the motors specification:

A manufacturer's standard motor may be supplied on packaged equipment, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), departure from rated voltage and frequency, poor ventilation, or frequent starting, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
   115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
   460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase. Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.8 SHOP TESTING. Each individual section of the gas fired boilers shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

When required, the equipment shall be factory tested. Factory test results shall be delivered to Engineer. Equipment shall not be shipped until Engineer has reviewed the test results and advised Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

2.9 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of topcoats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.3.01 Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body.

3.3.02 Gas Heating Water Boiler. The boilers shall be installed in accordance with the manufacturer's recommendations, and in a neat and workmanlike manner.

The boiler sections shall be held together by individual draw rods at the front and back of the assembly. A permanent gastight seal shall be maintained between the boiler sections.

Boiler installation shall include provisions for removing burners; adjusting, cleaning, and lubricating working parts; and replacing controls, safety devices, and other control components.

All boiler sections shall be sealed with high temperature mastic sealant in accommodating sealing grooves to provide a permanent gastight seal. Each port opening shall be equipped with a flexible elastomer sealing ring to ensure a permanent watertight seal between the boiler sections.

Care shall be exercised to avoid the transmission of pipe stresses to the equipment. The boiler shall be operated, adjusted, and tested after installation to confirm proper adjustment and operation of all controls.

Where required by applicable codes, gas train vent piping shall be routed to outdoors at a location acceptable to Engineer.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. When required, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field tests and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Initial startup of the boilers, including all burner equipment and burner controls, shall be provided through a qualified manufacturer's representative who shall record all burner and control settings. Copies of the records shall be made available to Engineer prior to acceptance of the equipment.

3.4.03 Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided as required. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner. Each boiler shall be thoroughly cleaned in accordance with the manufacturer's instructions prior to being placed in service.

End of Section

SECTION 15515

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of specialty valves, expansion tanks, air separators, pumps, devices, and appurtenances associated with the heating, ventilating and air conditioning hydronic systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturer's names have been listed as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as specified in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, and valves denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment

Name of manufacturer

Type and model

Construction materials, thicknesses, and finishes

Manufacturer's performance data

Overall dimensions and required service clearances

Net weight and loading distribution

Pumps

Name of manufacturer

Type and model

Construction materials, thicknesses, and finishes

Rotative speed

Size of suction and discharge nozzles

Overall dimensions and required service clearances

Net weight and loading distribution

Performance curves with the specified operating point clearly identified for each unit, type, and model with capacity in gallons per minute (L/s) as the abscissa and NPSH required and total pump head as the ordinate. The curves shall also indicate pump efficiency and brake horsepower.

Type of coupling

Data on shop painting

Motors

Name of manufacturer

Type and model

Horsepower (kW) rating and service factor

Temperature rise and insulation rating

Full load rotative speed

Type of bearings and method of lubrication

Net weight

Overall dimensions

Efficiency at full, 3/4, and 1/2 loads

Full load current and power factor

Locked rotor current

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting

Parts lists and predicted life of parts subject to wear

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. One mechanical seal for each size and type of pump shall be furnished for the equipment.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces except motors shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.08 Piping. Unless otherwise indicated herein, piping shall be as specified in Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies.

2.4.09 Valves. Unless otherwise specified herein, all valves shall be as specified in Master Specification Section 15100, Miscellaneous Valves.

Unless otherwise indicated, 2 inch (50 mm) and smaller valves shall have threaded end connections and 2-1/2 inch (65 mm) and larger valves shall be flanged.

2.4.09.01 Flow Control Valves. Flow control valves shall be Bell & Gossett "Circuit Setter", Taco, or approved equal. Readout kits shall be Bell & Gossett "Model RO-2", Taco “Model 789” , or approved equal.

Flow control valves shall be suitable for a working pressure of 125 psig (862 kPa gauge) at 250°F (121°C). Each flow control valve shall be equipped with readout ports fitted with an integral check valve designed to minimize system fluid loss during the balancing and monitoring process, and shall have a calibrated nameplate to ensure specific settings. Valves shall be located as indicated on the drawings, and shall be of the same size as the pipe in which they are installed. All valves shall be provided with preformed, molded insulation blocks to permit access for balancing and readout without disturbing system insulation.

A readout kit, compatible with the valves furnished, shall be provided as required. The kits shall be complete with one percent accurate, 0 to 100 feet (0 to 180 kPa) range pressure gauge; color coded hoses for low and high pressure connections; shutoff and vent valves; and carrying case. Upon completion of the work, the kit shall be delivered to Owner.

2.4.09.02 Combination Pump Discharge Valves. Combination pump discharge valves shall be Bell & Gossett "Triple Duty Valve", Taco, or approved equal.

Combination pump discharge valves shall be of straight pattern, flanged, with cast iron body and bolt-on bonnet. The valves shall be suitable for a working pressure of 175 psig (1207 kPa gauge) at 250°F (121°C). Each valve shall be equipped with nonslam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment for flow regulation. Each combination pump discharge valve shall be equipped with readout ports fitted with an integral check valve design to minimize the system fluid loss during the balancing and monitoring process. The valves shall be of the same size as the pipe in which they are installed and shall be suitable for use with the readout kits specified in the Flow Control Valves paragraph. The combination pump discharge valve shall be used for balancing service, not for isolation of the pump discharge.

2.4.09.03 Pressure Relief Valves. Pressure relief valves shall be Bell & Gossett "Model 790", or approved equal.

Pressure relief valves shall have a low blowdown differential and shall be designed to relieve system pressure as indicated on the drawings, within the maximum operating limits of the valve. Pressure relief valves shall be ASME rated and shall bear ASME nameplates. The valves shall incorporate fail-safe disc to ensure normal operation under emergency conditions.

2.4.09.04 Pressure Reducing Valves. Pressure reducing valves shall be Bell & Gossett "Model FB38", or approved equal.

Pressure reducing valves shall be diaphragm operated, with a low inlet pressure check valve and inlet strainer. The strainer shall be easily removed without shutting down the system. The valve seat, strainer, and stem shall be removable and shall be fabricated of corrosion-resistant material. The pressure reducing valve shall be set at the pressure indicated on the drawings.

2.4.10 Expansion Tanks. Expansion tanks shall be manufactured by Bell & Gossett "Series B" for bladder type, or “Series D” for diaphragm type, Taco, or approved equal.

The expansion tanks shall be pressurized diaphragm or bladder type. The tanks shall be furnished complete with a charging valve and other connections indicated on the drawings or otherwise required for a complete installation. The tanks shall be constructed of steel in accordance with the ASME Code for Unfired Pressure Vessels for a working pressure of 125 psig (862 kPa gauge) and shall bear ASME stamp. The tanks shall have an exterior coating of universal type primer.

The expansion tanks shall have the dimensions and capacity as required. Tanks oriented vertically shall be provided with an integral base suitable for vertical floor mounting. Tanks oriented horizontally shall be suitable for horizontal ceiling-hung installation.

2.4.11 Air Separators. The air separators shall be Bell & Gossett "Model R", Taco, or approved equal.

Air separators shall be constructed of carbon steel in accordance with ASME Code for Unfired Pressure Vessels for working pressures of 125 psig (862 kPa gauge) and shall bear ASME stamp. The air separator connections shall be of the same size as the pipe in which it is installed, and the air separator performance capacity shall be suitable for the system flow rate. The air separators shall include strainers with 3/16 inch (5 mm) perforations and a free area at least five times the cross sectional area of the connecting pipe. The maximum pressure drop shall not exceed 1 psi (7 kPa) at design flow. The air separators shall have an exterior coating of universal primer.

2.4.12 Air Vents.

2.4.12.01 Manual Air Vents. Manual air vents shall be Bell & Gossett "Model 4V", Taco, or approved equal.

Manual air vents shall have bronze bodies and nonferrous internal parts. The vents shall be manually operated using a screwdriver or thumbscrew.

Manual air vents shall have 1/8 inch (3 mm) discharge connections and 1/2 inch (15 mm) inlet connections. Air vents shall be designed for 150 psig (1034 kPa gauge) working pressure and 225°F (107°C) operating pressure.

2.4.12.02 Automatic Air Vents.

a. Type 1 Vents. Type 1 air vents shall be Bell & Gossett "Model 107A", Taco, or approved equal.

Type 1 air vents shall be float.actuated, non-modulating, high capacity type designed to purge air and provide shutoff at pressures up to 150 psig (1034 kPa gauge) and 250°F (121°C). The vent shall be constructed of cast iron and fitted with AISI Type 313 stainless steel, brass, EPDM, and silicone rubber internal components.

b. Type 2 Vents. Type 2 air vents shall be Bell & Gossett "Model 87", Taco, or approved equal.

Type 2 air vents shall be designed to purge air and to provide shutoff at pressures up to 150 psig (1034 kPa gauge) and 240°F (116°C). The vents shall be constructed of brass and cast iron with nonferrous internals.

2.4.12.03 Air Control Accessories. Other piping specialties shall be provided as indicated on the drawings or as needed for a complete system. Specialties shall be manufactured by the expansion tank manufacturer.

All supports, rods, anchors, and accessories required to properly support the tanks, separators, and specialties shall be provided.

2.4.13 Test Plug. Test plug fittings shall be Sisco "P/T Plugs", or approved equal.

Test plug fittings suitable for pipeline pressure and temperature testing shall be furnished and installed where indicated on the drawings. Test plug fittings shall be 1/2 inch (13 mm) NPT solid brass with dual seal core of neoprene and shall be rated zero leakage to 500 psig (3447 kPa gauge). Each fitting shall be furnished with a marked, color coded cap with gasket and brass cap chain. Fitting body shall be long enough to extend past the insulation on the piping.

In addition, Contractor shall furnish a test kit compatible with the test plug fittings furnished. The test kit shall consist of two thermometers with 1 inch (25 mm) dial faces, pressure gauges with 3-1/2 inch (89 mm) dial faces and gauge adapter. The thermometers shall have ranges of approximately 25°F to 125°F (-4°C to 52°C) and 0°F to 220°F (-17°C to 104°C) and the pressure gauges shall have ranges of approximately 0-60 psig (0-414 kPa gauge) and 0-150 psig (0-1034 kPa gauge). The kit shall include internally padded and fitted carrying case.

2.4.14 Chemical Feed Pot. Chemical feed pots shall be Hydac "By-Pass Chemical Feeder", or approved equal.

Chemical feed pots shall be furnished and installed where indicated on the drawings to feed poly-functional corrosion inhibiting chemical solutions to the water system. The feed pots shall be of steel, with a 5 gallon (23 L) capacity, and shall be suitable for use with water at a pressure of 150 psig (1034 kPa gauge) and a temperature of 210°F (99°C). Each feed pot shall have inlet and outlet connections, a bottom drain connection, and at least 3-1/2 inch (89 mm) fill opening with a fill cap. The feed pot shall be designed so that the fill cap cannot be removed when the chemical feeder is pressurized.

A plastic instruction panel engraved in at least 1/4 inch (6 mm) high black letters on white background shall be mounted adjacent to the feed pot, describing the valve sequence to be used.

2.4.15 Base Mounted Pumps and Accessories. Base mounted water pumps, denoted by the symbols "HWP" for heating water pumps, "CWP" for chilled water pumps, or “CDWP” for condenser water pumps and an identifying number, shall be Bell & Gossett "Series 1510", Taco, or approved equal.

Each base-mounted pump assembly shall consist of a pump, electric motor, coupling, coupling guard, and all other accessories required for proper operation. Pump capacities shall be as indicated in the schedules on the drawings.

Pumps shall be horizontal single stage, end suction, centrifugal type, of back pullout design suitable for being serviced without disturbing piping connections. The pump casings shall be cast iron, with gauge ports at the nozzles and vent and drain ports at the top and bottom of the casing. The impellers shall be bronze, enclosed type, keyed to the shaft. The casing wearing rings and shaft sleeve shall be constructed of bronze. Pump shafts shall be stainless steel. Shaft seals shall be a mechanical type, suitable for continuous operation at temperatures up to 225°F (107°C).

Pumps shall be electric motor driven and shall be direct connected to the drive motor through a flexible coupling. Each pump and motor shall be mounted on a common cast iron or fabricated steel sub-base suitable for installation on a concrete foundation as indicated.

Bearings shall be grease lubricated ball type with an L_{10} Life Rating of at least 40,000 hours at specified operating conditions. Pump motors shall conform to the requirements of the Electric Motors paragraph and shall be suitable for use with the power supply indicated on the schedules.

Heating water pumps shall be suitable for use with 200°F (93°C) water.

2.4.15.01 Suction Diffusers. Suction diffusers shall be furnished and installed for the heating, chilled, and condenser water pumps, as required. Each diffuser unit shall consist of cast iron angle type body with inlet vanes and combination diffuser strainer with 3/16 inch (5 mm) openings for pump protection. The units shall be designed for 175 psig (1207 kPa gauge) working pressure and at least 250°F (121°C) operating temperature. Each unit shall be provided with an adjustable support foot to carry the weight of the suction piping and shall be sized to fit the pump and system piping connections.

2.4.15.02 Flexible Connectors. Flexible connectors shall be Resistoflex "Model R6904", or approved equal.

Flexible connectors shall be furnished and installed for the suction and discharge of each pump and where indicated on the drawings. The connectors shall be multiple arch type with TFE T62 teflon bellows, monel reinforcing rings, control units, and flanged ends. The connectors shall be designed for use with water at a pressure of 100 psig (689 kPa gauge) and a temperature of 250°F (121°C).

2.4.16 Pressure Gauges. Pressure gauges shall be Ashcroft "Duragauge 1279", Weiss Instruments, Inc, or approved equal.

Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.

The dial shall be 4-1/2 inch (114 mm) in diameter with black markings on a white background. The units of measurement shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The scale shall be so arranged that the normal operating reading is near the midpoint of the range.

Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in Master Specification Section 15091, Miscellaneous Ball Valves.

All stem-mounted gauges shall be provided with 1/2 inch (13 mm) NPT connections.

2.4.17 Thermometers. Thermometers shall be furnished and installed where indicated on the drawings. The thermometer range shall be selected so that when installed and operating, the thermometer will read within the middle two-thirds of the scale range.

Each thermometer shall be furnished with a stainless steel thermowell for installation in steel piping systems or brass thermowell for installation in copper piping systems. The thermowells shall have 3/4 inch (20 mm) NPT thread mounts, a minimum pressure rating of 250 psig (1725 kPa gauge), and a nominal 4 inch (102 mm) insertion length.

2.4.17.01 Dial Type Thermometers. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle", Weiss Instruments, Inc. , or approved equal

Dial type thermometers shall be bimetal type and shall have at least 4-1/2 inch (114 mm) dial with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

Each indicator shall be furnished with an angularly adjustable frame for convenient viewing.

2.4.17.02 Stem Type Thermometers. Stem type thermometers shall be Weksler Instruments "Adjust Angle Thermometer" Weiss Instruments, Inc. "9VU", or approved equal.

Stem type thermometers shall be mercury type and shall have at least a 9 inch (225 mm) scale with black markings on a white background. Each thermometer shall have molded Valox polyester case, acrylic or shatterproof glass front, and angularly adjustable stem for convenient viewing.

2.5 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit.

2.6 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.6.01 Safety Guards. All couplings and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.6.02 Electric Motors. Motors furnished with equipment shall meet the following requirements.

A manufacturer's standard motor may be supplied on packaged equipment, fans, pumps, and heaters, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

Outdoor equipment.

Equipment for installation below grade.

Equipment operating in chemical feed and chemical handling locations.

Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor’S option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof or submersible motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

Below 1/2 hp (0.4 kW).
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

1/2 hp (0.4 kW) and above.
460 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.7 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the lastest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.3.01 Valves. Valves of the types and sizes specified herein shall be furnished and installed where indicated on the drawings and in the schedules and where required for proper operation of the systems. Where valves are furnished as an integral part of the equipment, additional valves serving the same purpose will not be required. Valves shall be installed with their stems horizontal or vertical and above the valve body.

All drain valves shall be 3/4" (19 mm) with hose connection unless otherwise indicated.

Except at circulating pump locations, all 4 inch (100 mm) and larger valves shall be installed in horizontal piping.

Provide all low points in the hydronic water system piping with drain connections.

3.3.02 Air Vents. Manual air vents shall be installed at all high points in the hydronic piping systems and at other locations indicated on the drawings.

Automatic air vents shall be installed in the hydronic piping systems where indicated on the drawings.

3.3.03 Base Mounted Pumps. The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field tests and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15525

DIGESTER HEATING BOILERS

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installing digester gas fueled heating water boilers as indicated on the drawings.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

1.2.01 General Equipment Stipulations. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Governing Standards. All work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, and laws and regulations of the state which pertain to such work. In case of conflict between these specifications and any state law or municipal ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories safety requirements.

The boiler and burner safety controls shall comply with the following:

ASME Section IV, Boiler and Pressure Vessel Code

Factory Mutual (FM)

Industrial Risk Insurers (IRI)

ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers.

NFPA 54, National Fuel Gas Code.

Definitions of terms and hydraulic considerations shall be as set forth in the Hydraulic Institute Standards.

1.2.03 Coordination. The Contractor shall assume full responsibility for coordination of the boilers with the heating water system, including verification that all structures, piping, and equipment components are compatible. The Contractor shall start up the system and shall make all necessary adjustments so that the system is placed in proper operating condition.

The drawings indicate the extent and general arrangement of the system. If the Contractor deems any departures from the drawings are necessary, details of such departures and the reasons therefor shall be submitted as soon as practicable to the Engineer for review. No such departures shall be made without the prior written concurrence of the Engineer.

1.2.04 Quality Assurance. The equipment to be furnished under this section shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the products of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Major items of mechanical equipment shall be of the best quality normally used for the purpose in good commercial practice and shall be the products of reputable manufacturers.

Several manufacturers are indicated as acceptable for each item of equipment in these specifications. The Contractor shall be responsible for determining that all equipment supplied for the project is suitable for installation in the space provided, as indicated on the drawings, with adequate operating and maintenance access space.

1.2.05 Elevation. The equipment will be operated at an elevation as required.

1.2.06 Power Supply. Power supply to equipment shall be as required.

1.2.08 Shop Painting. All ferrous metal surfaces of each boiler which are to be insulated shall be shop painted with a universal primer prior to installation of the insulation and protective enclosure. Panel boards and electrical controls shall be painted with black enamel. All other surfaces shall be painted with gray enamel. Heated surfaces shall be painted with heat resistant paint.

1.2.05 Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service as required. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1.3 SUBMITTALS. Complete assembly and installation drawings, together with detailed specifications and data covering material used and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master

Specification Section 01080, Projects Submittals. Device tag numbers indicated on the contract documents shall be referenced on the wiring and schematic diagrams where applicable.

The data and specifications for the boilers shall include, but shall not be limited to, the following:

Boiler

Manufacturer and model.

Performance data.

Dimensions.

Connection sizes and locations.

Approximate weight, wet and dry.

Control panel schematics and layout drawings.

Fuel Train

Valve manufacturer.

Valve materials.

Schematic.

Burner

Manufacturer and model.

Sequencing Control Panel

Schematics and layout drawings

1.3.03 Operation and Maintenance Data and Manuals. When required, adequate operation and maintenance information shall be supplied. Operation and maintenance manuals with Master Specification Section 01160, Training and Operation and Maintenance Manuals shall be submitted in accordance with the submittals section.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND SHIPPING. handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as required.

Spare parts shall be suitably packaged as required. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Each boiler will be used to heat water for digester and building heating. Each boiler will be dual-fueled with automatic switchover capabilities. Primary fuel shall be digester gas with backup fuel as required.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Each boiler shall be designed for the performance and design requirements as required.

2.4 DIGESTER HEATING BOILER.

2.4.01 Fire Tube Boiler. When required, boilers shall be a packaged, horizontal, multi-pass, fire tube, scotch marine type boiler with front and rear gasketed doors or panels to allow access for inspection and cleaning of the tubes and tube sheets. Boilers shall be constructed with water cooled combustion chamber and multi-pass fire tubes with separate tube sheets. Boilers shall be designed to provide a minimum of 5 square feet of heating surface area per rated boiler horsepower. Boilers shall be factory assembled.

2.4.01 Cast Iron Sectional Boiler. The boiler shall be a factory assembled package, cast iron, sectional type. Boilers shall be designed for vertical travel of flue gas. Each section of the boiler shall be manufactured with cast-on heat absorbing studs to transfer heat from the combustion gases to the boiler water. Boilers shall be designed and constructed so that the combustion chamber is completely surrounded by circulating water. Boiler sections shall be fabricated with ground-faced metal-to-metal joints which do not need putty, cement, or other filler. Each boiler shall be equipped with access openings for cleaning the flueways between sections.

Where the boiler physical size precludes the use of a packaged unit and with the written concurrence of Engineer, a field assembled unit will be acceptable. To minimize field assembly work, major components shall be shop assembled to the maximum extent practicable.

Boilers shall be furnished complete with a burner assembly, firing controls, control panel, fuel valve gas trains, electrical wiring, safety equipment, a structural steel base, lifting lugs, and all accessories and appurtenances specified or required for a complete, properly operating installation.

2.4.02 Burner Assembly. The burner shall be capable of operating on digester gas at the conditions as required and shall automatically switch to the secondary fuel. The pilot shall be suitable for operating fuel as required.

2.4.03 Burner Firing Controls. Burner controls shall provide positive control of the fuel supply to the burner and pilot. Burner controls shall be microprocessor based.

Control shall provide at least a 30 second purge of the combustion chamber before ignition of fuel and a 15 second or longer purge after interruption of the fuel supply.

An electronic scanning device shall sense pilot and main burner flame. Upon flame failure, the controls shall automatically interrupt the fuel supply to the pilot and the burner, sound an audible alarm, and light a visual indicator. A manual reset, low water cutoff switch, and a limit thermostat shall also interrupt operation of each unit. An isolated contact in the low water cutoff switch, which shall close on low water level, shall be wired to terminals in the control panel.

Except when flame failure occurs, automatic spark ignition and provisions for automatic restarting after a power failure or momentary interruption of the fuel supply shall be provided.

When required a signal shall be sent to start a boiler pump when a boiler is energized. The boiler shall not fire until flow is confirmed.

Each boiler unit shall be provided with a fuel selector switch with DIGESTER GAS, AUTO, and secondary fuel positions. When the switch is in the DIGESTER GAS or the secondary fuel position, the boiler shall operate on the single fuel indicated. In the AUTO position, priority shall be given for firing on digester gas, with automatic switchover to the secondary fuel on low digester gas supply pressure. The AUTO mode shall not allow automatic return from the secondary fuel firing to digester gas firing until the remote digester discharge gas pressure input contact indicates sufficient digester gas pressure has returned after an adjustable timer has timed out. Time delay shall be set with a timer furnished in the boiler control panel.

Digester gas and the secondary fuel shall be ignited by a proven gas pilot.

The boiler unit shall be provided with pressure regulators, valves, strainers, filters, fuel pump, and controls as required for the use of the specified fuels.

The burner shall be full modulation type. The gas train shall meet code requirements for burner safety controls as required. All materials in contact with digester gas shall be suitable for the gas. Unless otherwise specified, all valve trim in contact with digester gas shall be fabricated of stainless steel or aluminum. All automatic shutoff valves or vent valves shall have stainless steel bodies, hard-faced stainless steel seats, chrome plated stainless steel discs, and Viton seals, and shall be Maxon with trim 5-3. Pressure reducing valves shall have cast iron bodies and shall be Fisher or approved equal.

2.4.04 Air Fan. Each unit shall be equipped with a forced draft air fan sized to supply the air required for proper combustion of the fuel. Fan motor controls shall be interlocked with the automatic ignition system and the two fuel valves to provide the specified purge period prior to ignition and following cessation of ignition of the fuel. Each fan motor shall be suitable for operation with the specified power supply and shall be provided with a suitable starter.

Each unit shall be provided with all devices required to properly purge the combustion chamber and positively control the air volume produced by each fan to ensure proper combustion of the fuel.

2.4.05 Control Panel. An electrical control panel shall be provided and mounted on each boiler unit. A circuit breaker for suitable for the power supply shall be mounted on the control panel. In addition, fan motor starter, burner firing controls, control transformer, ignition transformer, alarm horn, fuel selector switch, lights, and all electrical controls and devices specified herein or otherwise required for proper operation of the equipment shall be mounted on the panel. The complete control panel shall have an interrupting rating of at least 42,000 amperes at 480 volts ac.

All controls shall be housed in NEMA Type 12 enclosures. All external wiring shall be enclosed in conduit.

Isolated contact outputs shall be provided as required. All contacts shall be rated for 5 amperes at 120 volt ac.

All electrical components of each unit shall be factory installed and wired so that only connection of the power supply circuit to the control panel is required during installation of the equipment.

All electrical components of the boiler unit shall be factory installed and wired so that connections of the power supply circuit to the control panel is required during installation of the equipment.

2.4.06 Boiler Trim. Boilers shall be provided with ASME safety relief valve, burner flame observation ports and additional trim items as required.

Observation ports shall be mounted on the front and back sections of the boiler to permit visual inspection of the burner flame.

Boiler pressure relief valves shall be of the side discharge type and shall be piped to the bottom of the unit. The valves shall be set to relieve at the rated boiler ASME working pressure. The valve shall have a discharge capacity equal to or greater than the listed output of the boiler.

2.4.07 Unit Enclosure. Each boiler shall be furnished with insulated heavy gage steel jacket with baked enamel finish and insulated with heavy density fiberglass.

2.5 SEQUENCING PANEL. When required a sequencing panel suitable for operating multiple boilers shall be provided. A loop-powered temperature transmitter, located in the boiler discharge header, shall be provided and shall send a 4-20 mA signal to the panel to allow automatic sequencing of lead/lag boilers and full modulation control of the burners. The control system shall be microprocessor based, pre-engineered and programmed. The sequencing panel shall be powered as required and shall be enclosed in a lockable steel, NEMA 1 enclosure. The panel controls shall be UL and CSA listed.

The panel shall include the following:

ON, OFF, AUTO, STANDBY selector switch for each boiler

Manual/Automatic Lead/Lag rotation switch.

Normally open contact for burner start/stop.

Control power transformer as required.

Burner firing rate controller.

Lead and activated boiler lights.

Ignition start adjustment for each boiler.

Modulation start adjustment for each boiler.

Terminals for accepting discrete signals from remote-mounted emergency shutdown switches.

Terminals for accepting a 4-20 mA signal from remote-mounted digester gas pressure switch.

Terminals for accepting a 4-20 mA signal from remote-mounted temperature transmitter

Temperature setpoint adjustment knob.

Purge timer.

Battery backup.

LED display of actual temperature, setpoint temperature, gain adjustment, and boiler percent modulation.

The lead/lag control of the boilers and modulation of the burner shall be based on the heating water supply temperature. On drop of supply water temperature, the lead boiler shall be energized. Following a time delay to allow the boiler to be fired, the controls shall begin modulating the lead burner upward at a rate proportional to the supply temperature rate of change. When the burner on lead boiler goes to high fire, the first lag boiler shall be energized and controlled similar to the lead boiler. When the burner of the first lag boiler goes to high fire, the second lag boiler shall be energized and controlled similar to the lead boiler. As the supply temperature rises, the modulation of the last boiler on line shall decrease until it gets to its ignition start point. It shall be held at that point until the previous on line boiler burner has been modulated to its ignition start point. The last boiler on line then shall be de-energized.

When the boiler fuel selector switch is in the AUTO position, controls shall be provided for automatic fuel switchover from digester gas to natural gas based on a 4-20 mA signal from a remote pressure transmitter. Priority shall be given to firing on digester gas. As the digester gas pressure decreases to a setpoint, the lag boilers shall be switched to fire on natural gas. If the pressure decreases to a setpoint pressure, the lead boiler shall be switched to fire on natural gas. When the pressure increases above the setpoint pressure, after a time delay, the lead boiler shall be switched back to fire on digester gas. If the pressure continues to increase, the lag boiler shall be switched back to fire on digester gas.

2.6 BOILER FLUE. Boiler flues shall be furnished and installed where indicated on the drawings. The boiler flue systems shall be factory built, laboratory tested and listed by Underwriters' Laboratories, and shall comply with the requirements of NFPA 211. Flue systems shall be designed and installed to be gastight to prevent leakage of combustion products into the building.

The boiler flue should be double walled with a nominal 1-inch air space between the walls. The inner and outer jackets shall be constructed of materials as required. The materials and construction of the modular sections shall be as specified by the terms of the product's UL listing.

Drain tee caps, stack caps, storm collars, and flanged boiler kits shall be provided. Caps shall be constructed of stainless steel materials. The systems shall be designed to compensate for all flue gas inducted thermal expansions. Flues shall be supported where indicated on the drawings and as required by the system’s manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished at locations determined by the flue systems manufacturer. The entire system from each boiler to the termination, including accessories, shall be the product of one manufacturer.

The flue systems shall be installed according to the manufacturer's installation instructions and shall comply with all applicable codes. The flue systems shall be Selkirk Metalbestos "Model PS" or approved equal.

2.4.08 Anchor Bolts. Anchor bolts and nuts shall be furnished as required for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

The bolts shall be at least 3/4 inch (19 mm) in diameter.

Anchor bolts shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2-1/2 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with thickness of approximately 1/2 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be furnished with each anchor bolt.

All anchor bolts, nuts, and washers shall be carbon steel, stainless steel, or galvanized steel, as required.

Anchor Bolts and Nuts

Stainless Steel	AISI Type 316, 316L; Bolts ASTM F593, Alloy Group 2; Nuts ASTM F594, Alloy Group 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.
Flat Washers	ANSI B18.221; of the same material as the bolts and nuts.

Anchor bolts shall be long enough to accommodate at least 1-1/2 inches (38 mm) of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2.7 SHOP TESTING.

2.7.01 Hydrostatic Tests. When required, each boiler shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

2.7.02 Fire Test. When required and after assembly, each boiler shall be filled and brought to and maintained at operating temperature with the furnished burner using either the primary or secondary fuel specified. In addition, control functional tests shall be performed.

2.7.03 Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

PART 3 - EXECUTION

3.1 INSTALLATION. The equipment shall be installed in accordance with the manufacturer's recommendations, and all work shall be completed in a neat and workmanlike manner. Installation shall provide the required accessibility for adjusting, cleaning, and lubricating working parts; and replacing controls, safety devices, and other control components. Care shall be exercised to ensure that piping stresses are not transmitted to the equipment. Each unit shall be operated, adjusted, and tested after installation as required to ensure proper adjustment and operation of all controls.

Each boiler shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. The base for each boiler shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. No stresses shall be transmitted to the boiler flanges. After final alignment and bolting, boiler connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3.2 INSTALLATION CHECK. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work for at least 1 days (travel time excluded) and inspect, check, adjust if necessary, start-up, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

Each manufacturer's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3 TRAINING. Training shall be as specified in the Master Specification Section 01160, Training and Operation and Maintenance Manuals. A minimum of 8 hours of training shall be provided to instruct the Owner's operating and maintenance personnel in the actual operation and maintenance of the new boilers once the equipment is in proper working condition.

The training time required shall be separate from the time required in paragraph 3.2.

End of Section

SECTION 15550

HEATING SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heating system equipment, flues, heaters, and associated devices and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations In Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Equipment Motors

Name of manufacturer.

Type and model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Bearing types and numbers.

Weight.

Overall dimensions.

Full load amperes, efficiency, and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

Flue piping and fittings shall be factory built, laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211.

Electric heaters shall be UL listed unless otherwise indicated. Electric duct heaters shall comply with the National Electrical Code.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer'S review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 SPARE PARTS. One burner flame detector and boiler pressure relief valve shall be furnished for the equipment.

Spare parts shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Spare parts shall be delivered to Owner as directed.

Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules. Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as indicated.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be in accordance with Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 FLUE SYSTEMS. Flues shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Flue system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions.

2.5.01 Factory Built Flues. Flue systems for gravity vented equipment and vertically vented unit heaters listed for use with "Type B" gas vents shall be Selkirk Metalbestos, "Type B" gas vents, Metal-Fab, or approved equal. The flue systems for power vented equipment shall be Selkirk Metalbestos "Type PS" gas vent, Metal-Fab "Model PIC", or approved equal.

The flue pipe and fittings for vertically power vented unit heaters requiring a 5 inch (125 mm) or smaller flue and gravity vented equipment shall be a "Type B" gas vent. The flue shall be of double wall construction, with a 0.25 inch (6 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch (0.3 mm) aluminum and the outer jacket of at least 0.018 inch (0.5 mm) galvanized steel. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

The flue pipe and fittings for power vented equipment and power vented unit heaters requiring a 6 inch (150 mm) or larger flue shall be of double wall construction with a nominal 1 inch (25 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch (0.9 mm) AISI Type 304 or Type 316 stainless steel, as required, and the outer jacket of at least 0.025 inch (0.6 mm) aluminum coated steel for interior locations and Type 304 or AISI Type 316 stainless steel, as required, for the portions of the stack exposed to the outdoor environment. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

2.5.02 Metal Flues. The flue pipe and fittings for horizontally power vented unit heaters requiring a 5 inch (125 mm) or smaller flue shall be constructed of at least 24 gage (0.61 mm) thickness galvanized steel and shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The flue system shall include all necessary fittings, hangers, supports, and flashings.

2.6 HEATERS. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2.6.01 Baseboard Heaters. Baseboard heaters, denoted by the symbol "BH" and an identifying number, shall be Chromalox, Electromode, or approved equal. The heater model shall be as indicated.

Baseboard heaters shall be constructed of heavy gage, cold-rolled steel. The heating element shall be an aluminum finned tube, suitable for a maximum operating temperature of 400°F (204°C) in an ambient temperature of 70°F (52°C). Watt density of the element shall not exceed 187 watts per foot (614 w/m). Heaters shall be equipped with a thermal limit control, built-in thermostat, shall be prewired for service connection in boxes of equal dimensions at both ends and shall be suitable for use with the indicated power supply.

2.6.02 Cabinet Heaters. Cabinet heaters, denoted by the symbol "CH" and an identifying number, shall be manufactured by McQuay, Trane, or approved equal. The heater model shall be as indicated.

Cabinet heaters utilizing the required heat source shall be furnished and installed as indicated on the drawings. Cabinet heaters shall be complete with controls and accessories as needed for satisfactory operation. The cabinet heaters shall include a chassis, coil, fan assembly, filter, motor, motor disconnect, and insulation.

Cabinet heaters shall be vertical or horizontal as indicated in the schedules on the drawings with a front discharge grille, a bottom return, and a built-in thermostat. Heater casings shall be of steel construction with a minimum 16 gage (1.52 mm) thickness front panel and 18 gage (1.21 mm) thickness end and top panels. Exposed corners and edges of the cabinet heater shall be rounded. Heater casings shall be insulated, furnished with removable access panels, and shall be finished with lacquer or enamel. Finish color shall be selected by Engineer from the manufacturer's standard line of colors.

The cabinet heater fans shall be direct driven, centrifugal, forward-curved, double-width wheels statically and dynamically balanced. Fan motors shall have integral thermal overload protection and shall be suitable for use with a 120 volt, 60 Hz, single phase power supply. When necessary, factory-mounted transformers shall be provided to step down voltage for the control circuit.

Water coils shall be 5/8 inch (16 mm) OD seamless copper tubes mechanically bonded to aluminum fins. The coils shall be suitable for a working pressure of 300 psig (2069 kPa gauge), shall be factory tested for leaks under water at 300 psig (2069 kPa gauge), and shall be rated for entering water and entering air temperatures as indicated in the heater schedule on the drawings.

Electric heating elements shall be finned tube or open coil as required. The units shall be factory wired with a unit-mounted heat switch, magnetic contactors, a high temperature cutout safety control, and a fan override thermostat.

Cabinet heaters shall be provided with removable 1 inch (25 mm) disposable filters located in front of the heating coil.

2.6.03 Heating Water Convectors. Heating water convectors, denoted by the symbol "C" and an identifying number, shall be Trane, or approved equal. The heater model shall be as indicated.

Convector elements shall be constructed of copper tubes expanded and rolled into cast iron headers. Fins shall have integral collars which space the fins, and shall be bonded to the tube by mechanical expansion of the tube. End supports shall carry the weight of element and shall be designed to fit over header.

The cabinet shall be constructed of 14 gage (1.9 mm) thickness or heavier carbon steel reinforced with channel stiffeners. Fronts shall be secured by quick-opening fasteners.

Convector cabinets shall have a baked enamel finish of a color selected by Engineer from manufacturer's standard colors.

Dampers to reduce heating capacity by up to 70 percent when closed shall be factory mounted on the element.

Convector capacity shall be as indicated in the schedule on the drawings.

Convectors shall have 24 inch (610 mm) high cabinets.

2.6.04 Electric Duct Heaters. Electric duct heaters, denoted by the symbol "EDH" and an identifying number, shall be manufactured by Indeeco, Brasch, or approved equal.

Electric duct heaters shall be furnished and installed where indicated on the drawings.

Electric duct heaters shall be open coil or finned tube, as required, and zero clearance type with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames with 2 inch (50 mm) wide flanges suitable for fastening to the ductwork.

Bushings for open coils shall be ceramic and terminals shall be stainless steel. Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

Heaters shall be completely factory wired and shall be provided with disconnecting backup and safety contactors, transformers, an automatic reset thermal cutout, a manual reset thermal cutout, a disconnect switch, and a differential pressure airflow switch. All interconnecting wiring shall be enclosed in a terminal box fastened to the heaters and oriented as indicated on the drawings. The terminal boxes shall be furnished with double doors.

Contactors shall be 600 volt rated, 3 pole, UL listed, and shall have a life expectancy for 100,000 operations. A built-in industrial dry type 480/120 volt control transformer shall be furnished to carry the full contactor holding coil load. Transformer primary and secondary windings shall be fused. Secondary windings shall have one lead grounded.

The duct heaters shall be furnished with a silicone controlled rectifier (SCR) control unit mounted in the duct heater terminal box. The control unit shall be suitable for the temperature range of 32 to 132°F (0 to 55°C), and shall be a solid-state proportioning controller designed to modulate the heater output from 0 to 100 percent. The duct heaters shall be controlled by a thermostat as indicated on the drawings. The duct heater SCR controller shall be compatible with the signal from the thermostats.

The duct heater output in kW shall be as specified at 460 volts, 60 Hz, 3 phase. The heater elements shall be suitable for operation on 480 volt, 60 Hz, 3 phase power.

2.6.05 Electric Infrared Heaters. Electric infrared heaters, denoted by the symbol "IH" and an identifying number, shall be manufactured by Chromalox, or approved equal. The heater model shall be as indicated.

Electric infrared heaters shall be metal sheathed double element type, with 30 degree symmetrical reflector for a narrow controlled beam pattern.

Reflectors shall be constructed of clear anodized aluminum. The heater housing shall be constructed of 20 gage (0.91 mm) thickness steel finished with neutral gray baked enamel.

The heaters shall be mounted at 30 degrees from horizontal.

Electric infrared heaters shall be UL listed and suitable for use with the power supply indicated in the heater schedule on the drawings. Capacities shall be as indicated in the heater schedule on the drawings.

2.6.06 Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the drawings.

Electric Unit Heaters (non-explosionproof). Electric unit heaters located in unclassified areas shall be Chromalox "LUH" or "VUH", Brasch, or approved equal. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the drawings to be wall hung, a wall mounting bracket shall be provided.

Electric Unit Heaters (explosionproof). Where indicated in the heater schedule on the drawings to be explosionproof, unit heaters shall be manufactured by Indeeco "Ultra-Safe", Ruffneck, Markel, or approved equal. Explosionproof electric unit heaters shall be of the fan forced type with a heat exchanger, fan and motor assembly, automatic reset thermal cutout, built-in contactor, factory installed three pole disconnect switch in NEMA 7 enclosure, and 24 volt control transformer. The heater shall be suitable for use with the power supply indicated in the heater schedule on the drawings. The heater shall be listed for installation in a Class I, Division 1 or 2, Group D location and shall have an NEC ignition code of T3B or better.

The heater cabinets shall be constructed of a corrosion resistant cabinet fabricated from an epoxy coated 14 gage (1.90 mm) thickness steel with individually adjustable outlet blades. Cabinet fasteners shall be stainless steel.

The heat exchanger shall be an efficient liquid to air design utilizing a copper or steel core with aluminum fins. The heat exchanger shall be provided with a coating suitable for use in a corrosive atmosphere consisting of hydrogen sulfide. The heating elements shall be housed in an inhibited propylene or ethylene-glycol heat transfer fluid that is suitable for temperatures down to -49°F (-45°C). A pressure relief valve shall provide overpressure protection for the heat exchanger.

The fan and motor assembly shall consist of an aluminum fan connected to a explosionproof, permanently lubricated ball bearing type motor with built-in thermal overload protection. The motor shall be prewired to the control enclosure providing for a heater that is suitable for use with a single point power connection.

<u>Electric Unit Heaters (corrosion resistant)</u>. Where indicated on the drawings to be corrosion resistant, unit heaters shall be manufactured by Indeeco "Traid", Chromolox "HDH", or approved equal. Each heater shall include fan and motor assembly, operating and safety controls, and shall be suitable for use with a single point power supply indicated in the schedules on the drawings.

Heater elements shall be Type 304 or 316 stainless steel, fin tubular type, with stainless steel fittings forming a watertight seal between the elements and the junction box. Unit heater fan motors shall be totally enclosed, permanently lubricated ball bearing type designed to resist corrosion and moisture. The fan blades shall be epoxy coated aluminum and the heater housing shall be at least a 20 gage (0.91 mm) Type 304 stainless steel. Where indicated on the drawings to be wall hung, a swivel wall mounting bracket shall be provided.

The controls shall include automatic reset thermal cutout, fan delay relay, built-in control and motor contactors, control transformer, and terminal block all housed in a NEMA 4X enclosure. A pilot light visible on the heater exterior shall indicate heater operation.

2.6.07 Gas Unit Heaters. Gas unit heaters, denoted by the symbol "GUH" and an identifying number, shall be Reznor Model "Venturion FE", Trane, Sterling, or approved equal.

Gas unit heaters shall be furnished and installed where indicated on the drawings. Each heater shall be of the type, size, and capacity indicated in the schedules on the drawings; shall be suitable for use with the gas type and pressure as required; and shall be of a type approved and listed in the AGA Directory of Approved Gas Appliances and Accessories.

Each gas-fired unit heater shall be power vented, horizontal discharge, propeller type, and suitable for two point suspending mounting. The heater burner and heat exchanger shall be constructed of E-3 (AISI Type 409) stainless steel. Each heater shall be furnished with a vent cap.

Each gas unit heater shall be furnished complete with a 24 volt transformer, single-stage gas control with a regulated combination redundant gas valve, a spark-ignited, intermittent safety pilot with electronic flame supervision and all required limit and safety controls. Units larger than 125,000 Btu [132,000 kJ] input shall have two-stage gas controls.

The fan motor shall be suitable for use with a 120 volt, 60 Hz, single phase power supply, and shall be provided with automatic reset thermal overload protection.

2.6.08 Heating Water Unit Heaters. Heating water unit heaters, denoted by the symbol "HUH" and an identifying number, shall be manufactured by Modine, Trane, Armstrong-Hunt, Inc., or approved equal

Heating water unit heaters shall be of the discharge orientation indicated, propeller type and shall be suitable for use with the power supply indicated in the schedules on the drawings. The heating water unit heaters shall be rated for entering water and entering air temperatures as indicated in the schedules on the drawings. The noise level generated by each heater shall be appropriate for the space in which the heater is installed. Efficient air deflectors shall be provided for each heater. Heater casings shall be of sturdy, rigid steel construction and shall be finished with lacquer or enamel. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Heating water unit heater capacities and discharge arrangement shall be as indicated in the schedules on the drawings.

Where indicated in the schedules on the drawings to be explosionproof, unit heaters shall be suitable for installation in an NEC Class I, Division 2, Group D area.

2.6.09 Wall Heaters. Wall heaters, denoted by the symbol "WH" and an identifying number, shall be manufactured by Electromode "Model EWA", Brasch, or approved equal.

Wall heaters shall be downflow type; designed for surface mounting; and shall include an electric heating element, a thermal limit switch, a fan delay switch, a fan and motor assembly, and a built-in thermostat. The heaters shall be suitable for use with the specified power supply and shall have the capacity indicated in the schedules on the drawings.

2.7 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements,, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under the electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.8 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.8.01 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.8.02 Electric Motors. Motors furnished with equipment shall meet the following requirements unless otherwise specified in the motors specification:

> A manufacturer's standard motor may be supplied on packaged equipment, fans, pumps, and heaters, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally

enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40° C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feed and chemical handling locations.

4. Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor'S option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

1. <u>Below 1/2 hp (0.4 kW)</u>.
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. <u>1/2 hp (0.4 kW) and above</u>.
460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase. Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.9 <u>SHOP TESTING</u>. The equipment shall be factory tested. Factory test results shall be delivered to Engineer. Equipment shall not be shipped until Engineer has reviewed the test results and advised Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

2.10 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the lastest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath base plates shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body.

3.3.02 Flues. Flues for all equipment exhausting combustible material shall be installed where indicated on the drawings. Flue gas systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

Flues shall be supported where indicated on the drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the flue systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

The flue height dimensions indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

All vertical flues shall be equipped with a capped tee to serve as a condensate drain. Flues 6 inches (150 mm) and larger shall be equipped with a condensate drain connection.

When power vented equipment is listed as being suitable for use with "Type B" gas vents, "Type B" gas vents may be used when all vent joints are sealed to prevent leakage.

Where metal flues are used, each joint shall be sealed with sealant and/or aluminum or teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Where single wall metal flues are used to vent equipment, a double wall flue shall be used outside and shall extend through the wall a minimum of 6 inches (150 mm). The annular space of the double wall flue shall be sealed at the connection point between the double and single wall flues. Single wall flues routed through unconditioned spaces or in locations below 8 feet (2.4 m) above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150°F (65°C).

Gas unit heater flues shall be installed with a minimum of 12 inches (300 mm) of straight pipe attached to the venter outlet before the installation of an elbow.

3.3.03 Heaters. The bottom elevation of unit heaters shall be 8 feet (2.4 m) above finished floor unless otherwise indicated.

Gas fired unit heaters with side burner and control access shall have the access located on heater side opposite the wall.

Electric duct heaters shall be installed with a minimum distance of 4 feet (1.2 m) from all ductwork transitions and obstructions on both sides of the heater.

3.4 FIELD QUALITY CONTROL.

3.4.01 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field tests and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

3.2 CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner. Each boiler shall be thoroughly cleaned in accordance with the manufacturer's instructions prior to being placed in service.

End of Section

SECTION 15575

FLUE STACKS, BREECHINGS AND VENTS

PART 1 - GENERAL

1.1 SCOPE. Furnish and install all flue stacks, breechings and vents as shown on the Drawings, schedules and as specified herein.

1.2 RELATED REQUIREMENTS. Section 15855 - Air Handling Units

1.3 SUBMITTALS. Submit, in accordance with Section 01160, the following: Catalog cuts and assembly directions for each type of flue or stack.

1.4 REFERENCE STANDARDS. Underwriters Laboratories (UL).

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

The complete system shall meet all applicable governing codes.

PART 2 - PRODUCTS

2.1 GENERAL. Type H or SS Factory Built Chimney - UL listed for use with residential and commercial buildings when forced venting is not required. The double wall metal chimney shall have an outer casing of aluminum coated steel (0.4 oz/sq ft), an inner casing of Type 430 or equal corrosion resistant stainless steel and a minimum dead air space of 1/2-in. Chimney shall be complete with UL listed support plates, roof thimble and guy wires and other accessories as recommended by the manufacturer for a complete installation as manufactured by Metalbestos or equal.

Type PS - UL listed for use with forced venting equipment (MAUS). The system shall be completely design by the flue manufacturer with accessories required as manufactured by Metalbestos or equal. Outer and inner casings shall be 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION. Flues for all equipment exhausting combustible material shall be installed where indicated on the drawings. Flue gas systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counter flashed to provide a weather tight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

The flue height dimensions indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work. Flues shall be supported where indicated on the drawings and where required by the system manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

Install all equipment per manufacturer's recommendations.

End of Section

SECTION 15650

REFRIGERATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of refrigerant piping and accessories, condensing units, heat pumps, room air conditioners, packaged air conditioning units, package heat pumps, water chillers, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for functions and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein as indicated in the Contract Documents, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15.

Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, unless otherwise indicated on the drawings.

Capacity ratings for condensing units, heat pumps, packaged air conditioning units, and packaged heat pumps with capacities less than 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 210/240. For condensing units, heat pumps, packaged air conditioning units over 135,000 BTUH (39 kW) the capacity ratings shall be in accordance with ARI Standard 360. Capacity ratings for packaged heat pumps with capacities over 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 340.

Water chiller construction, ratings, and testing shall conform to the requirements of ANSI/ARI 590.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, and valves denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Air Cooled Condensing Units/Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity and saturated suction temperature at specified conditions.

Equipment efficiency ratings.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Room Air Conditioners

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Certified performance data and ratings.

Capacity at specified conditions.

Overall dimensions and required clearances.

Wiring diagrams and electrical requirements.

Net weight.

Information on local equipment manufacturers' representatives.

<u>Packaged Air Conditioning Units/Packaged Heat Pumps</u>

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

<u>Water Chillers</u>

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Certified performance data and ratings.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Bearing types and numbers.

Weight.

Overall dimensions.

Full load amperes, efficiency, and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied and shall be submitted in accordance with the Master Specification Section 01160, Training and Operation and Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. One complete change of lubricating oil and two sets of air filters shall be furnished for the equipment.

Extra materials shall be packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as required.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates will be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.08 Refrigerant Piping and Accessories. Refrigerant piping shall conform to Master Specification Section 15070, Copper Tubing and Accessories. Piping shall be supported as specified in Master Specification Section 15140, Pipe Supports. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.

The refrigerant piping size and arrangement shall be in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and sound transmission to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform oil return to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute (5 m/s) in vertical risers with upward gas flow and 500 feet per minute (2.5 m/s) in horizontal piping. The full load pressure drop should not exceed 3 psi (20 kPa) or 2°F (1°C) change in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute (20 m/s). The liquid lines shall be sized to limit the pressure loss to an equivalent of 2°F (1°C) of temperature change and a maximum liquid line velocity of 360 feet per minute (1.8 m/s).

2.5 EQUIPMENT.

2.5.01 Condensing Units/ Heat Pumps. Condensing units, denoted by the symbol "CU" and an identifying number and heat pumps denoted by the symbol "HP" and an identifying number, shall be furnished and installed where indicated on the drawings. Each unit shall consist of compressor(s), condenser coil, condenser fan(s) and motor(s), starters, and all controls necessary for proper operation. Condensing units and heat pumps shall be manufactured by Trane, Carrier, McQuay, York, or approved equal.

2.5.01.01 Performance and Design Requirements. Each unit shall be completely factory assembled and tested, piped, internally wired, and shipped in one piece. Condensing units and heat pumps shall be selected to satisfy the cooling and cooling/heating requirements of the air handling unit being served. A 2°F (1°C) suction temperature difference for piping losses shall be allowed between the condensing unit or heat pump and the air handling unit when in the cooling mode.

As required, condensing units and heat pumps shall be capable of satisfactory operation in the cooling mode at the minimum ambient air temperature indicated. When required to operate in the cooling mode at a lower temperature than the factory standard, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F (-18°C) consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature. Heat pumps shall be capable of operating satisfactorily at an ambient air temperature of 0°F (-18°C) in the heating mode.

The condensing units and heat pumps shall be designed to operate on the power supply as indicated on the drawings.

2.5.01.02 Casing. The unit casing shall be of weatherproof design, constructed of heavy gage galvanized or zinc-coated steel, and reinforced and braced for maximum rigidity. All bracing and reinforcing members shall be integral to each unit. The casing shall be given a factory-applied coat of rust-inhibitive universal primer, followed by the manufacturer's standard baked enamel finish. Fasteners shall be stainless steel or coated for corrosion protection. Each unit shall have removable panels or access doors for access to all components and connections. Drainage holes shall be located in the base section for moisture removal. The unit shall be supported above the mounting surface with base rails or feet.

2.5.01.03 Outdoor Coils. Outdoor coils shall be of the air-cooled, finned tube type with liquid accumulator and integral subcoolers. The coils shall be constructed of 3/8 inch (10 mm) OD seamless copper tubing with aluminum fins securely bonded to the surface. Coils shall be factory leak and pressure tested at 425 psig (2930 kPa gauge) and then completely dehydrated and sealed with a holding charge of nitrogen or refrigerant. The coils shall be protected from hail damage by louvered metal grilles or on units 5 tons or less, corrosion resistant wire maybe used.

2.5.01.04 Fans and Motors. Outdoor fans shall be vertical discharge, direct-driven propeller type, and shall be statically and dynamically balanced. Fan guards shall be located on the discharge of each fan. Fan motors shall be TEFC suitable for outdoor installation and shall have permanently lubricated ball bearings and built-in overload protection.

2.5.01.05 Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Where the compressors are located outside the cabinet, grilles shall be installed over the openings to protect the compressor area.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. The minimum number of capacity step reductions shall be as required. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2.5.01.06 Refrigerant Circuit and Accessories. Each unit shall be completely factory assembled, tested, and fully charged with Refrigerant-22 and compressor oil. Each refrigerant circuit shall be equipped with filter-dryer and multiuse liquid and gas line valves. The multiuse valves shall be constructed of brass with service pressure gauge ports. For condensing units and heat pumps larger than 20 tons (70.3 kW), factory mounted suction and discharge pressure gauges shall be provided. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

Heat pumps shall be provided with reversing valve, flow control check valve, and solid state defrost control system. The defrost system shall be a time and temperature initiated system that activates in response to a temperature sensing element mounted at the outdoor coil.

A hot gas bypass kit, including but not limited to a solenoid valve and hot gas bypass valve shall be provided for each condensing unit larger than 5 tons (17.5 kW). For condensing units larger than 20 tons (70.3 kW), the kits shall be factory installed. For condensing units smaller than 20 tons (70.3 kW), the kit maybe field installed.

2.5.01.07 Controls. Condensing units and heat pumps shall be completely factory wired for a single point power supply connection. All wiring shall be installed in accordance with the National Electrical Code.

Condensing units and heat pumps 5 tons (17.5 kW) or less shall be provided with factory wired control panel containing magnetic contactors, relays, and control power transformer. Units larger than 5 tons (17.5 kW) shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor and outdoor fan motors and internal volt control power transformer.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat, supply voltage terminal points for remotely located refrigerant solenoid valves, and terminal points to energize remote condensing unit and heat pump indicating lights.

An electrically separate, normally open contact shall be furnished to actuate remote indication of unit shutdown in the event any of the safety interlocks automatically shuts down the unit. The contact shall close on any safety condition except low refrigerant suction pressure.

A thermostat for operation of the unit shall be furnished and installed as indicated on the drawings. The thermostat type shall be as needed to perform the sequence of operation as indicated on the drawings.

The thermostat shall be a programmable or a nonprogrammable heating and cooling type with automatic changeover. The number of stages shall be suitable for the unit control and operation. The thermostat shall have a range of approximately 50 to 90°F (10 to 32°C) with at least a 5°F (3°C) deadband between heating and cooling. The thermostat shall have a subbase to control system and fan operation.

2.5.02 <u>Room Air Conditioner</u>. A room air conditioner denoted by the symbol "RAC" and an identifying number, shall be furnished and installed where indicated on the drawings. The unit manufacturer and model number shall be as indicated.

The unit shall be complete with hermetic motor-compressor, evaporator coil, condenser coil, fan motor, evaporator blower and condensing fan, drain pan, built-in thermostat, and all other necessary operating and safety controls. The slide-out chassis shall be mounted in a heavy gage galvanized steel cabinet. The unit shall provide positive exhaust and ventilation and shall have easily removable, washable filter. The unit shall be designed to operate on the power supply as indicated on the drawings.

2.5.03 <u>Packaged Air Conditioning /Heat Pump Units</u>. Packaged air conditioning units, denoted by the symbol "PAC" and an identifying number, and packaged heat pumps denoted by the symbol "PHP" and an identifying number shall be furnished and installed where indicated on the drawings. Each unit shall be designed for outdoor installation on a full perimeter curb or equipment pad as indicated on the drawings. The packaged air conditioning unit shall be manufactured by Trane, Carrier, McQuay, York, or approved equal.

2.5.03.01 <u>Performance and Design Requirements</u>. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with Refrigerant-22 and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated. The unit shall be suitable for the power supply and shall have the capacities indicated on the drawings.

The refrigeration system shall be capable of satisfactory operation at outdoor ambient air temperatures of 50°F (10°C) in the cooling mode and for heat pumps, 0°F (-18°C) in the heating mode. When required to operate in the cooling mode at a lower temperature than the factory standard, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F (-18°C) consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

2.5.03.02 Casing. The unit casing shall be of weatherproof design and shall be constructed of 20 gage (0.91 mm) or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have one inch (25mm) thick, one pound (454 kg) density, insulation coated on the air side. Aluminum foil-faced glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed access doors or removable panels shall be provided to permit easy inspection and maintenance. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

Where an economizer package is not specified, a manually set air damper shall be furnished to provide the indicated outside air volume.

2.5.03.03 Indoor Coil Section. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig (1380 kPa gauge). The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions.

2.5.03.04 Heating Sections. When indicated on the drawings, the unit shall have an electric heating coil, gas heating section, or auxiliary electric heating coil. Electric heater coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the drawings.

Gas-fired heating sections shall be completely factory assembled and wired integral within the unit. When located upstream of the cooling coil, the heating section shall be AGA design certified specifically for outdoor applications upstream of a refrigerant cooling coil. The heat exchanger shall be of constructed of minimum 20 gage (0.91mm) aluminized steel. The burner shall be induced or forced draft type with pressure regulator, redundant main gas valve, manual shutoff valve, and intermittent spark ignition. A flame sensing device and high limit safety controls shall be provided. The number of heating stages shall be as indicated in the schedules on the drawings.

The unit shall be supplied with natural gas having a calorific value of approximately 1000 Btu per cubic foot (37 MJ/m^3) at an inlet pressure as required.

2.5.03.05 Filters. Filters shall be mounted integral within the packaged air conditioning or heat pump unit and shall be 2 inches (50 mm) thick. Hinged access doors shall be provided. Filters shall conform to the requirements in Master Specification Section 15880, Air Distribution Systems.

2.5.03.06 Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons (17.5 kW) and smaller shall have direct or belt driven fans. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons (17.5 kW) shall have V-belt drive with adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Motors and Motor Controls paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the drawings are external to the complete unit. Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column (0.087 kPa) shall be used for 2 inch (50 mm) pleated filter losses.

The outdoor fans shall be direct drive, vertical discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2.5.03.07 Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning or heat pump unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2.5.03.08 Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoors coils, expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, refrigerant piping, and a full operating charge of refrigerant. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, compressor, and refrigerant charge. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

2.5.03.09 Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak and pressure tested. The coils shall be protected with hail guards.

2.5.03.10 Accessories. Where indicated on the drawings, the packaged unit shall be provided with economizer cycle to automatically utilize up to 100 percent of outside air for cooling. The economizer shall be controlled as required, and shall modulate return and outside air dampers to maintain proper discharge temperature into the conditioned space. The dampers shall be equipped with automatic lockout when the outside air temperature is too high for proper cooling, and shall have adjustable minimum position control. The damper motor shall be spring return and shall operate to close the outside damper during shutdown. A means for 100 percent relief of the return air shall be provided unless otherwise noted.

Where indicated on the drawings, hot gas bypass shall be installed to provide reduced capacity control.

When required, packaged units shall be furnished with a roof mounting curb. The curb shall be constructed of at least 16 gage (1.52 mm) zinc-coated steel with nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply and return air openings. The curb shall be a minimum of 16 inches (405 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.5.03.11 Controls. Each packaged unit shall be completely factory wired and shall have a single point power connection and unit mounted disconnect switch. All wiring shall be installed in accordance with the National Electrical Code.

The unit shall be provided with remote control and monitoring panel consisting of system operation switches and signal lights. The signal lights shall be for power, outage, dirty filters, and reset relay.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal volt control power transformer.

Defrost controls, electronic timed initiated and temperature terminated with field adjustable timer shall be provided for all packaged heat pumps. When auxiliary electric heating is provided, a factory installed emergency heat package shall be provided. When heating is locked out, the auxiliary heat shall be activated as necessary.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the drawings.

The thermostat shall be a manual changeover, automatic changeover, or programmable heating and cooling type. The number of stages shall be suitable for the unit control and operation. The thermostat shall have a range of approximately 50° to 90°F (10° to 32°C) with at least a 5°F (3°C) deadband between heating and cooling. The thermostat shall have a subbase to control system and fan operation.

2.5.04 Water Chillers. Packaged water chillers, denoted by the symbol "WC" and an identifying number, shall be furnished and installed where indicated on the drawings. The water chillers shall be manufactured by McQuay, Carrier, Trane, or approved equal.

2.5.04.01 Performance and Design Requirements. The package chillers shall consist of compressors, evaporator, shell and tube type condenser, thermal expansion valve, refrigerant accessories, and control panel. The chillers shall be completely factory assembled, wired, factory run tested. The complete assembly shall be mounted on a structural steel base.

The water chiller capacity and the evaporator and condenser fouling factors shall be as indicated in the schedules on the drawings. The capacity indicated is a minimum capacity. Units furnished shall be provided with sufficient capacities to account for tolerances due to manufacturing and testing variations. The minimum coefficient of performance (COP) and integrated part-load value (IPLV) shall meet the latest version of the ASHRAE Standard 90.1.

2.5.04.02 Compressors. Each compressor shall be a reciprocating, direct drive, 1750 rpm, semi-hermetic type suitable for use with Refrigerant-22. The compressors shall be equipped with suction and discharge service valves, hot gas muffler, internal relief valves, double-mesh suction inlet screens, and shall be mounted on spring isolators.

Each compressor shall be furnished with forced feed lubrication system complete with reversible, positive displacement oil pump, oil charging valve, oil level sight glass, and oil filter arranged to provide lubrication during startup, normal, and stopping operations. A crankcase heater shall be provided to prevent dilution of the oil by the refrigerant.

The compressor motor shall be suction gas cooled with solid state motor protector and shall have automatic capacity reduction equipment consisting of suction valve unloaders. As required, the minimum number of capacity step reductions shall be as indicated. Each compressor shall start unloaded.

2.5.04.03 Evaporators. The evaporators shall be shell and tube type with removable heads, internal water baffles, and integrally finned seamless copper tubes expanded into tube sheets. Each tube shall be individually replaceable. The evaporators shall be constructed, tested, and stamped in accordance with the ASME Code for Unfired Pressure Vessels for a refrigerant side working pressure of 225 psig (1550 kPa gauge) and a water side working pressure of 150 psig (1035 kPa gauge), and shall be insulated with 3/4 inch (19 mm) flexible closed cell plastic insulation.

2.5.04.04 Condensers. The condensers shall be shell and tube design with high strength steel shell and seamless, integral fin, copper tubes expanded into tube sheets. The condensers shall be constructed, tested, and stamped in accordance with the ASME Code for Unfired Pressure Vessels for a refrigerant side working pressure of 300 psig (2070 kPa gauge) and a water side working pressure of 150 psig (1035 kPa gauge). Each condenser shall have an integral subcooler circuit and a safety pressure relief.

Where potable water is supplied to the condenser, the condenser construction shall be suitable for use with potable water. Tubes shall be constructed of 90/10 cuppro-nickel, tube sheets shall be monel clad, and the heads epoxy coated.

2.5.04.05 Refrigerant Circuit. Each package chiller shall have a liquid line shutoff valve, filter dryer, liquid line sight glass with moisture indicator, liquid line solenoid valve, thermal expansion valve, compressor discharge service valve, insulated suction line, pressure relief device, and a charging valve. Chillers which have multiple compressors shall use independent refrigerant circuits. Each circuit shall be permitted to be shutdown without impacting the operation of the other circuit. The chillers shall be pressure tested, evacuated, and given full operating charge of Refrigerant-22 at the factory.

2.5.04.06 Accessories. The compressor shall be enclosed by a sound attenuator consisting of an acoustically lined compartment of 16 gage (1.52 mm) metal with one inch (25mm) of 1-1/2 pound (24 kg/m^3) density glass fiber lining.

When required, the chiller shall have hot gas bypass permitting the unit to operate down to 10 percent of the full load capacity. The hot gas bypass shall include hot gas bypass valve, solenoid valve, manual shutoff valve and all required controls. Units with hot gas bypass need not include a lead-lag compressor control.

Rubber-in-shear or spring isolators shall be provided for installation beneath the unit frame.

Each chiller shall be fitted with a gauge package consisting of high and low side refrigerant pressure gauges per refrigerant circuit and oil pressure gauge per compressor. A shutoff valve shall be included for each gauge.

Each chiller shall be provided with an evaporator and condenser water flow switches.

Condenser water regulating valves shall be provided by the chiller manufacturer.

2.5.04.07 Controls. A factory-built control panel with hinged access doors shall be mounted on each chiller. The control panel shall contain provisions for single point power connection, non-fused disconnect switch, starters, safety controls, control power transformer, fused control circuit, and terminal strips. Each compressor shall be provided with starter and motor contactors, non-recycling three phase compressor overload protection, and current overload protection. The starter type shall be as required. All accessories provided with the unit as specified herein and indicated in the sequence of operations shall be prewired for power and control to the unit control panel by the unit manufacturer.

A standard control package, or a microprocessor based interface shall be provided, as required.

As indicated, a factory-built sequence control panel shall be provided to control a multiple chiller system as set forth in the Sequence of Operations on the drawings.

2.5.04.07.01 Standard Control Package. The control panel shall have lights to indicate the status of all unit safeties, power, and compressor staging. An individual light shall be provided for each safety condition. An electrically separate, normally open contact shall be furnished to actuate a remove indication in the event any of the safety interlocks, except low refrigerant suction pressure, automatically shuts down the unit.

Each chiller circuit shall have recycling pump-down control, high pressure control, low pressure control, motor protector with oil pressure cutout, and low temperature cutout. An anti-recycle timer and timed periodic pumpout shall be provided to prevent rapid compressor cycling and liquid slugging. Except for units with hot gas bypass on one refrigerant circuit, units with multiple compressors shall have lead-lag compressor control.

A chilled water temperature controller and sensor set to maintain a nominal 45°F (7°C) leaving chilled water temperature shall cycle the compressors and activate the cylinder unloaders in response to the supply/return chilled water temperature.

2.5.04.07.02 Microprocessor Based Interface. The control panel shall contain a microprocessor based interface system capable of controlling the unit operation, setting control parameters, and monitoring alarm status. The microprocessor control system shall be pre-programmed with English language display, non-volatile memory, and shall be capable of displaying alarm diagnostics. Entering/leaving evaporator temperatures, entering/leaving condenser water temperatures, suction temperature of each circuit, suction pressure, discharge pressure, and alarm status shall be displayed using the interface system.

2.6 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.7 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.7.01 Adjustable Frequency Drives. Adjustable frequency drives shall be provided as indicated on the drawings and shall be coordinated with the requirements of the associated equipment. The equipment manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

Adjustable frequency drives shall be as covered in Master Specification Section 16150, Variable Frequency Drives.

2.7.02 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor.

2.7.03 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm thick) or thicker galvanized or aluminum-clad sheet steel or from ½ inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.7.04 Electric Motors. Motors furnished with equipment shall meet the following requirements.

> A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

Outdoor equipment.

Equipment for installation below grade.

Equipment operating in chemical feed and chemical handling locations.

Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

<u>Below 1/2 hp (0.4 kW)</u>.
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

<u>½ hp (0.4 kW) and above</u>.
460 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

Motors to be used with adjustable frequency drives shall be rated for inverted service.

2.8 <u>SHOP TESTING</u>. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

2.9 <u>BALANCE</u>. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the lastest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath the baseplate shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the miscellaneous valve sections.

3.3.02 Refrigerant Piping and Accessories. The refrigerant piping shall be sized and arranged in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and transmission of sound to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform return of oil to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute (5 m/sec) in vertical risers with upward gas flow and 500 feet per minute (2.5 m/s) in horizontal piping. The full load pressure drop should not exceed 3 psi (20 kPa) or 2°F (1°C) change in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute (20 m/s). The liquid lines shall be sized to limit the pressure loss to the equivalent of 2°F (1°C) of temperature change and a maximum liquid line velocity of 360 feet per minute (1.8 m/s). A piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

3.3.03 Condensing Units/Heat Pumps. The condensing units and heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the drawings.

After the refrigerant system has been tested, the system shall be fully charged with refrigerant 22 and compressor oil.

3.3.04 Packaged Air Conditioning Units/Packaged Heat Pumps. The packaged air conditioning units and packaged heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the drawings.

3.3.05 Water Chillers. Packaged water chillers shall be installed in accordance with the manufacturer's installation instructions. Each chiller shall be installed level on vibration isolators firmly anchored to the concrete equipment base. Piping around chiller shall be arranged for easy dismantling and permit tube cleaning.

The chiller safety relief valve shall be piped to outdoors at a location not less than 15 feet (4.6 m) above grade and not less than 20 feet (6.1 m) from any operable window, ventilation opening, or exit. The discharge termination shall be arranged to prevent direct spray on personnel in vicinity and foreign material from entering the discharge piping. The pipe size shall be as recommended by the water chiller manufacturer.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

3.4.03 Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5. CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

End of Section

SECTION 15755

HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heat exchangers for the locations and services as indicated.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts and Tools shall apply to all equipment provided under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet (1 m) of clear access space shall be provided on all sides of the unit.

1.2.03 Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1.2.04 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow convenient collection of waste oil in containers from the operating area or platform without removing the unit from its normal installed position.

1.2.05 Abbreviations. Reference to standards and organizations herein shall be as indicated by the following designations.

AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
NEMA	National Electrical Manufacturers Association
NPT	National Pipe Thread
UL	Underwriters' Laboratories
USS	United States Standard

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment drawings showing dimensions, connection sizes and locations, and maintenance clearances.

Unit shipping and operation weights.

Heat transfer capacity rating.

Design conditions of heat transfer capacity rating.

Heat transfer surface area.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.5 SPARE PARTS. A matched set of V-belts and matched set of gaskets shall be provided.

Spare parts shall be suitably packaged with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The heat exchangers shall be suitable for the service conditions as indicated.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Heat exchangers and accessories shall be designed for the performance and design requirements as indicated.

2.3 MATERIALS.

Plate and Frame Heat Exchangers	
Plates	As required.
Guide Bars	Stainless or chrome plated steel.
Frame	Carbon steel.
Tie Bolts	Stainless or zinc plated steel.
Gaskets	One-piece molded elastomer suitable for the specified service.
Cover	Galvanized steel, 14 gage (1.89 mm) minimum thickness.
Air-Cooled Heat Exchangers	
Frame	Carbon steel, galvanized.
Core	Continuous aluminum plate fins mechanically bonded to tubes.
Fan Impeller	Aluminum; air foil design.
Shell and Tube Heat Exchangers	
Shell	Fabricated steel.
Tubes	Inhibited Admiralty
Tube Sheets	90-10 Cu Ni
Rust-Preventive Compound	As recommended by manufacturer.

2.4 CONSTRUCTION. Connections 2-1/2 inch (63 mm) and larger shall be ANSI B16.5, Class 150 flanges. Connections 2 inch (50 mm) and smaller shall be NPT threaded.

Each unit shall be provided with provisions for lifting.

Each exchanger shall be designed to ASME Section VIII requirements. The heat exchanger shall bear the ASME stamp for unfired pressure vessels.

2.5 PLATE AND FRAME EXCHANGERS. Plate and frame type heat exchangers shall be constructed with a frame suitable for mounting on a concrete pad foundation. Plates shall be corrugated and shall include flow directors which shall evenly distribute the fluids over the exchange surface. Each plate shall have provisions for support and proper alignment of the members. Plates shall be of standard size of the manufacturer and replaceable with minimum disassembly of the unit. Each heat exchanger shall be provided with a protective sheet metal cover over the plate sections which can be easily removed without disturbing the piping connections. Heat exchangers shall be shop assembled with all openings sealed prior to shipment.

2.6 AIR-COOLED EXCHANGERS. Air-cooled heat exchangers shall consist of the heat exchange core section complete with fan and structural frame suitable for mounting on a concrete pad foundation. Manifolds shall be removable for access to and cleaning of tubes. Core shall be pitched to a drain connection with shutoff valve.

Fans shall be forced draft driven by an electric drive motor.

2.7 SHELL AND TUBE EXCHANGERS. Shell and tube type heat exchangers shall be horizontal tube type with removable tube bundle. Exchangers shall be constructed with fabricated channels at each end. Channels shall have flanged and bolted covers which can be removed without disturbing any piping connections

Shells shall be of welded construction and include provisions for expansion of one of the tube sheets and channels if required by the manufacturer's design for the specified conditions. Shells shall have two supports suitable for mounting on concrete pad foundations. All necessary connections shall be provided for piping, vents, drains and instruments.

Tubes shall be rolled into the tube sheets and shall be adequately supported to prevent sagging or vibration. The method of expanding the tubes shall be such as to not change the size of the tube sheet opening. The tube bundle supports shall be arranged as baffles to obtain the most effective distribution of the fluid above and around the entire tube bundle.

Tube sheets shall be of adequate thickness for the design pressures and physical size of the exchanger with a minimum thickness of one inch. Tube holes shall be arranged on a triangular pitch. Tube hole edges shall be chamfered on the shell side and each hole shall be provided with a minimum of two grooves. The bridge between tube holes shall be not less than 3/16 inch (5 mm) nominal.

2.8 ACCESSORIES.

2.8.01 Relief Valves. A relief valve shall be furnished on each liquid side of each exchanger. Relief valves shall have manual lifting levers and shall be capable of protecting the exchanger from overpressure in the event the exchanger is operated with closed isolation valves.

2.8.02 Temperature Switches. Temperature switches shall be provided in the air-cooled exchanger manifold for control of the fan. Switches shall close on rising temperature to start the fan motor. Switch contacts shall be rated at least 10 amperes at 120 volts ac.

2.8.03 Anchor Bolts. Anchor bolts and nuts shall be furnished as required for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

The bolts shall be at least 3/4 inch (19 mm) in diameter.

Anchor bolts shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2-1/2 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with thickness of approximately 1/2 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be furnished with each anchor bolt.

All anchor bolts, nuts, and washers shall be carbon steel, stainless steel, or galvanized steel.

Anchor Bolts and Nuts

Carbon Steel	ASTM A307 or ASTM A36.

Stainless Steel

AISI Type 304, 305, 384, 304L	Bolts ASTM F593, Alloy Group 1; Nuts ASTM F594, Alloy Group 1.
AISI Type 316, 316L	Bolts ASTM F593, Alloy Group 2; Nuts ASTM F594, Alloy Group 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.
Flat Washers	ANSI B18.22.1; of the same material as the bolts and nuts.

Anchor bolts shall be long enough to accommodate at least 1-1/2 inches (38 mm) of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2.9 DRIVE UNITS Each fan shall be driven by an electric motor. Drive units shall be designed for 24 hour continuous service.

2.9.01 Belt Drive When belt drives are required by the manufacturer's design, V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 4 to 1. Each belt drive shall include a sliding base or other suitable means of tension adjustment.

2.9.02 Safety Guards All belt drives, fan blades, couplings, and other moving or rotating parts of the units shall be covered on all sides by a safety guard, fabricated from 16 USS gage (1.52 mm thick) or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and shall be furnished complete with all necessary supports and accessories. Supports and accessories, including bolts, shall be galvanized. Safety guards in outdoor locations shall be designed to keep out rain and dripping water.

2.9.03 Electric Motors. The electric motors shall be as indicated in Master Specification Section 16220, General Purpose Induction Motors.

2.10 SHOP COATING. All steel and iron surfaces shall be protected by suitable shop-applied coatings. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment with coatings suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for coating. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for being top-coated in the field with a universal primer and aliphatic polyurethane system.

Machined, polished, and nonferrous surfaces shall be coated with rust-preventive compound.

All other surfaces to be coated after installation shall be prepared for coating as recommended by the coating manufacturer for the intended service, and then shop coated with one or more coats of the specified shop primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.
2.11 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price for the number of days and round trips to the site as required.

3.2.02 Installation Supervision. The equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the contract price.

Manufacturers' installation supervisor shall observe, instruct, guide, and direct the installing contractor's erection or installation procedures. The equipment manufacturer will be notified with written notification 10 working days prior to the need for such services.

3.3 TRAINING. The manufacturer's representative shall provide training for Owner in proper operation and maintenance of the equipment. Such services shall be included in the contract price.

End of Section

SECTION 15820

DEHUMIDIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of equipment and accessories associated with the dehumidification systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thicknesses. Metal thicknesses and gages as indicated on the Contract Documents are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Temperature Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but not be limited to, the following:

Name of manufacturer.

Type and model.

System flow diagram.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Process fan horsepower.

Reactivation fan horsepower.

Precooling equipment data and capacities.

Post heating equipment data and input/output capacities.

Reactivation heater equipment data and input/output capacities.

Filter velocities.

Dehumidifier performance curves or data and desiccant type.

Process and reactivation entering and leaving air conditions.

Fan performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. A set of air filters, fan belts, and other belts shall be furnished for each equipment unit.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The dehumidifiers shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The dehumidifier capacities shall be as indicated in the schedules on the drawings.

Gas fired dehumidifiers shall be suitable for operation with a natural gas or propane inlet pressure range as indicated.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as required.

2.2.03 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as indicated in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 DESICCANT DEHUMIDIFIERS. Honeycomb wheel type desiccant dehumidifers shall be Bry-Air "Model VFB", Cargocaire, or approved equal. Each unit shall be complete with desiccant wheel, process and reactivation air fans, reactivation heaters, volume dampers, motor starters, and a control panel, and shall be completely assembled, wired, and tested at the factory. The dehumidifier shall be capable of removing moisture continuously from the process air stream.

2.5.01 Casing. The unit casings shall be welded aluminum construction with a thickness of at least 0.125 inches (3.2 mm) and shall be properly braced and reinforced with aluminum framework as needed for the operating pressures. The casing shall be provided with the manufacturers standard finish.

Gasketed removable panels or doors shall be furnished to provide access to all internal parts and components. The cabinet shall be constructed to be vapor tight for indoor installation. An observation window shall be provided to permit visual inspection of the bed while the unit is in operation.

The reactivation air and process air sides of the unit shall be divided by a positive sealing arrangement designed for at least 20,000 hours of normal operation. The seals shall be removable and access doors shall be provided for inspections.

2.5.02 Desiccant Wheel. The dehumidifier shall use an automatic, continuous duty, honeycomb style desiccant wheel as required for the adsorption medium. The desiccant material shall be chemically inert, non-corrosive, non-flammable, non-toxic type, and shall contain no asbestos. The wheel shall have a flame spread of 0 and a smoke developed rating not to exceed 10 when tested in accordance with ASTM E84.

The desiccant wheel shall be belt driven and shall have a maximum wheel rotation speed of 10 revolutions per hour.

2.5.03 Reactivation Heater. The type of reactivation heaters shall be electric, direct fired gas, or steam, as indicated in the schedules on the drawings.

2.5.03.01 Electric Type. Electric reactivation air heaters shall consist of an electric heating coil with solid-state modulating control. The controls shall be able to modulate the electric heating coil capacity from 0 to 100 percent. The electric heating coil shall be of open coil zero clearance construction with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames. Bushings shall be ceramic and terminals shall be stainless steel. The electric heating coil control panel shall be completely factory wired to the unit control panel and shall include disconnecting backup and safety contactors, transformers, fusing, disconnect switch, automatic reset thermal cutout, manually reset thermal cutout, and differential pressure airflow switch.

2.5.03.02 Natural Gas Type. Natural gas reactivation air heaters shall consist of a modulating direct fired burner, suitable for use with natural gas. The controls shall be able to modulate the burner firing rate to match the reactivation air requirements. The complete fuel burning assembly shall conform to the requirements of the UL/ETL, FM, or IRI as required. The burner assembly and gas piping arrangement shall include pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valve, electric modulating main gas valve, low and high pressure safety switches, flame rod, spark igniter, ignition transformer, and flame safeguard relay. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment and shall be suitable for an inlet gas pressure range as required.

2.5.03.03 Steam Type. Steam reactivation heaters shall provide heat for the dehumidifier by a steam heating coil utilizing steam. The steam coil shall be a non-freeze type constructed of 5/8 inch (16 mm) OD copper tubes with at least a 0.049 inch (1.2 mm) wall thickness mechanically bonded to aluminum fins. Coils shall be rated for 150 psi (1030 kPa) and tested at 300 psi (2070 kPa) steam working pressure.

Modulating dampers capable of modulating the heating capacity from 0 to 100 percent shall control the reactivation air temperature to match the reactivation air requirements.

2.5.04 Fans. Both process and reactivation air fans shall be factory mounted as part of the unit base. The fans shall be of the single width, single inlet, multiblade, centrifugal type with motor, belt, drives, and guards and shall be arranged to provide counterflow arrangement of the process and reactivation airflows. The fans shall be dynamically balanced and tested after being installed in the factory-assembled fan section. Fans shall be mounted on vibration isolators.

Belt-driven fans shall be complete with V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with smaller than 10 horsepower (7.5 kW) motors and fixed sheaves for 10 horsepower (7.5 kW) and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the appropriate size after the air system balancing, if necessary, to achieve the fan speed required for the specified airflow.

Multiple belts shall be provided in matched sets.

Static pressure values indicated on the schedules are external to the complete unit. The desiccant wheel, filters, and fan housing losses are not included. A filter allowance of 0.35 inch water column (87 Pa) shall be used for filter losses.

A high static fan shall be provided if required to overcome the fan total static pressure.

2.5.05 Filter Section. Dehumidifiers shall be provided with built-in filter racks or filter enclosures fastened directly to the process and reactivation air inlets. Racks or enclosures shall be suitable for housing two inch (50 mm) thick pleated filters. Gasketed access doors shall be provided for removal of filters. Filters shall be removable when the dehumidifier equipment is installed as indicated on the drawings. Air filters shall conform to the requirements of the Air Filters paragraph.

2.5.06 Accessories. Factory mounted volume dampers shall be factory mounted in both the process and reactivation air streams. Dampers shall be of the opposed blade type with positive locking quadrants. A 4 inch (100 mm) U-tube manometer complete with tubes and probes shall be factory installed across the unit for measuring pressure differentials.

2.6 REFRIGERANT DEHUMIDIFIERS. Refrigerant dehumidifiers shall be Desert Aire "LT Series", Dectron, or approved equal as required. Each unit shall be of the packaged, self-contained, closed loop, refrigerant type, completely factory assembled, piped, wired, and tested at the factory. Dehumidifiers shall be of the horizontal type suitable for suspended mounting. The units shall be complete with supply fan, fan motor, compressor, evaporator coil, condenser coil, refrigeration valves, and electrical controls.

2.6.01 Casing. The unit casing shall be constructed of at least 20 gage (0.91 mm) thickness steel and shall be properly braced and reinforced with steel framework as needed for maximum rigidity. The base panel shall be a minimum 14 gage (1.9 mm) thickness steel with welded 1/8 inch (3 mm) steel angle supports on the underside for maximum rigidity. Removable panels shall be provided to allow easy access to internal parts within each section. Access shall be on the side indicated on the drawings. The unit casing and panels shall be provided with the manufacturer's standard enamel finish. The electrical control panel shall be housed in a separate compartment.

The enclosures shall be internally insulated with a flame-attenuated glass fiber insulation bonded with a thermosetting resin. The air stream surface shall be faced with a black coated mat. The insulation shall be securely fastened to the unit enclosure by mechanical means. The insulation shall not exceed a flame spread rating of 25 when tested in accordance with ASTM E84.

2.6.02 Coils. Both the evaporator and condenser coil tubes shall be fabricated from 1/2 inch (13 mm) OD seamless drawn copper. The fins shall be die-formed, plate-type tempered aluminum for easy cleaning and shall be damage resistant.
The tubes shall be hydraulically extruded into the fins to form a permanent metal-to-metal bond. All manifolds, headers, and connecting tubing shall be made with heavy wall seamless copper tubing. Coils shall be leak tested at pressures not less than 400 psig (2760 kPa gauge). Coils shall be designed and tested in accordance with UL and CSA standards. After testing, coils shall be sealed.

Air velocity across evaporator and condenser coils shall not exceed 500 FPM (2.5 m/s). Evaporator coils shall be at least six rows deep with a maximum of ten fins per inch (25 mm). Condenser coils shall be at least four rows deep with a maximum of twelve fins per inch (25 mm).

2.6.03 Compressors. Compressors shall be heavy-duty hermetic reciprocating type with crankcase heater to protect against liquid slugging or scroll type. Compressors shall be equipped with low and high pressure safety switches, and shall be internally protected from overheating. Compressors shall be vibration-isolated internally and externally.

2.6.04 Fans. Dehumidifiers shall have a double-inlet, double-width, centrifugal, forward-curve fan mounted on permanently lubricated sealed or grease lubricated ball bearings, selected for 200,000 hours of average life. Fans shall be dynamically and statically balanced. Fan housings shall be vibration-isolated.

Belt-driven fans shall be complete with V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Sheaves shall be of the adjustable type and shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the appropriate size after the air system balancing, if necessary, to achieve the fan speed required for the specified airflow.

Multiple belts shall be provided in matched sets.

Static pressure values indicated on the schedules are external to the complete unit. Internal coil(s), filter and fan housing losses are not included. A filter allowance of 0.35 inch water column (87 Pa) shall be used for filter losses.

A high static fan shall be provided, if required, to overcome the fan total static pressure.

2.6.05 Filter Section. Dehumidifiers shall be provided with built-in filter racks or filter enclosures fastened directly to the process air inlets. Racks or enclosures shall be suitable for housing filters one or two inches (25 or 50 mm) thick. Gasketed access doors shall be provided for removal of filters. Filters shall be removable when the dehumidifier equipment is installed as indicated on the drawings. Air filters shall conform to the requirements of the Air Filters paragraph.

2.6.06 Accessories. Dehumidifiers shall be furnished with a sloped condensate drain pan constructed of stainless steel and positioned under the dehumidifier coil. The drain pan shall extend sufficiently past the evaporator coil to capture and collect any condensate carryover that may occur when the unit is operating. It shall be formed of 20 gage (0.91 mm) thickness stainless steel, silver-solder welded, and attached securely to the evaporator end plates. The drain pan shall be pitched to completely drain and fitted with a 1 inch (25 mm) NPT non-corrosive plastic drain connection.

Refrigerant type dehumidifiers shall include the compressor and condenser fan motor starters; start and run capacitors; high and low pressure control with manual reset of the high pressure cut out, and automatic reset of low pressure cut out; anti-cycling timer to protect against compressor cycling, and indicating lights. Indicating lights shall be provided to indicate system, fan, and compressor operation.

Refrigerant type dehumidifiers shall also include an electrically controlled damper assembly within the unit enclosure to maintain optimum coil temperature under varying load conditions. The unit shall be equipped with a low ambient valve to control discharge pressure regardless of ambient condensing temperatures. A hot gas bypass valve to prevent the coil from freezing shall be provided. A diverting valve shall be provided to control refrigerant flow through the condenser coil or water-cooled condenser depending on space temperature requirements.

2.7 AIR FILTERS. Filters shall be American Air Filter "AM-AIR 300X", Farr "30/30", or approved equal. Filters shall be disposable type, with 1 or 2 inch (25 or 50 mm) thick, high-loft blend of cotton and synthetic fiber pleated media. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame.

Unless otherwise specified, all filters shall have an average efficiency of 25 to 30 percent based on the ASHRAE 52.1-92 test method. The filters shall have a maximum initial resistance of 0.13 inch water column at 300 feet per minute (30 Pa at 1.5 m/s).

2.8 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.9 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.9.01 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor unless otherwise indicated.

2.9.02 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.

2.9.03 Electric Motors. Motors furnished with equipment shall meet the following requirements.

> A manufacturer's standard motor may be supplied on packaged equipment in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall

be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feeding and chemical handling locations.

4. Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor’s option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
   115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
   460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase. Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.10 CONTROLS. Dehumidifiers shall be provided with an electrical control panel. The control panels shall be easily accessible after dehumidifier installation. Control panels shall be factory prewired with protective fuses, contactors, motor starters, control transformer, overload protection, pilot lights, relays, and all necessary components to insure continuous automatic operation. The control panels shall be of adequate size to house all electrical controls and devices necessary to provide control as described in the Sequence of Operation. Controls shall be suitable for 120 volts, 60 Hz, single phase power supply.

Humidistats for on-off operation of the unit shall be furnished and installed where indicated on the drawings

A condensation controller for on-off operation of the unit shall be furnished and installed. The controller shall consist of a control power module and a sensor module mounted where indicated on the drawings. The control power module shall contain the power supply, differential setpoint adjustment switch, signal indicating lights, and control relay to start and stop the dehumidifier. The sensor module shall continuously monitor the surface humidity level and the control power module shall compare it to the selected differential dew point setting and control the unit accordingly.

2.11 SHOP TESTING. The equipment shall be factory tested and the test results shall be delivered to Engineer. Equipment shall not be shipped until Engineer has received the test results and advised Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

2.12 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3.2.02 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. The dehumidification systems shall be installed where indicated on the drawings. Flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. The flexible connections shall comply with the requirements of Master Specification Section 15880, Air Distribution Systems.

Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.4.03 Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided as required. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as necessary for compliance.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15845

REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of stainless steel supply registers and exhaust grilles, and appurtenances associated with heating and ventilation systems. It shall include the following duct mounted air outlets and inlets:

Supply Registers

Exhaust Grilles

1.2 SUBMITTALS.

1.2.01 Product Data. For each model indicated, include the following:

Data Sheet: Indicate construction, finish, and mounting details for each type of air outlet, inlet, and accessory indicated.

Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet indicated.

Schedule of registers and grilles indicating drawing designation, room location, quantity, model number, size, and accessories.

Assembly Drawing: Indicate materials and methods of assembly of components for each type of air outlet and inlet indicated.

1.3 QUALITY ASSURANCE. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS. In other Part 2 articles where subparagraphs titles below introduce lists, the following requirements apply for product selection:

Products: Subject to compliance with requirements, provide one of the products specified.

2.2 REGISTERS.

2.2.01 Supply Register. Stainless Steel, 3/4” spacing, Double-Deflection

Acceptable Manufacturers:

Titus; Model 300 RL-SS.

Krueger

Or approved equal

Material: Roll-formed, Type 304 Stainless Steel

Face Blade Arrangement: Adjustable parallel to short dimension

Rear Blade Arrangement: None.

Frame: 1-1/4 inches

Mounting: On Ductwork.

Damper Type: Adjustable opposed-blade assembly, Type 304 Stainless Steel.

2.3 GRILLES.

2.3.01 Exhaust Grille. Stainless Steel, 3/4” spacing, 45° fixed deflection

Acceptable Manufacturers:

Titus; 350 RL-SS

Krueger

Or approved equal

Material: Roll-formed, Type 304 Stainless Steel

Face Blade Arrangement: 45° Fixed parallel to long dimension

Frame: 1-1/4 inches

Mounting: On Ductwork.

2.4 SOURCE QUALITY CONTROL.

2.4.01 Testing. Test performance of registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION. Ductwork-Installed outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable.

Install registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

End of Section

SECTION 15855

AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SCOPE. Furnish and install all indoor make-up air handling units with filters as shown on the Drawings, scheduled and as specified herein.

1.2 SCHEDULES. All units shall be of the type, capacity and arrangement as listed on the schedules. Units shall consist of the components listed in the schedule and those components obviously required for the type of unit. Unit shall be capable of being installed together in sections in the final location where shown on the drawing or as one entire unit. The order of component assembly will be as called for on the schedule. Particular attention must be paid to the remarks and notes in these schedules.

1.3 SUBMITTALS. Submit, in accordance with Sections 01160 and 15501, the following:

Unit data sheets; to include catalog data, a description of the proposed unit, size, type, arrangement, and materials of construction.

For belt drive equipment, provide drive data indicating sheave sizes, belt size, number and length.

Each submittal shall include pertinent equipment dimensional data, heating and cooling coil operating data. Submit, in accordance with Sections 01160 and 15501, all data and the fan schedules. The submittal shall include fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data information, and a performance curve showing the fan operating point and range. Minimum curve size shall be 8-in by 6-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted.

Significant dimensional differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. The Contractor shall provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.

For condensing sections provide information on number and type of compressors, type of refrigerant and refrigerant charge, and controls provided and operating weight. Provide electrical data for power and controls. For condensing coils, provide air entering and leaving conditions, air pressure drop, size, type, arrangement, and materials of construction.

List of accessories to be furnished shall be included on each submittal. Provide a recommended list of spare parts.
Significant dimensional differences between the specified equipment versus the proposed equipment shall be noted on the equipment submitted.

For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

All submittals shall contain a statement that Section 15501, and all other Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

Submit to the Engineer as provided in Section 01730, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.

Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual.

Contents - Each volume shall contain the following minimum contents:

Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

In general, corrections or comments or lack there of, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4 REFERENCE STANDARDS. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

ASHRAE 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

Air Movement and Control Association (AMCA) National Fire Protection Association (NFPA)
NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems

NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

American Society for Testing and Materials (ASTM)

ASTM C581 - Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass- Fiber- Reinforced Structures Intended for Liquid Service.

ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Materials).

Air-conditioning and Refrigeration Institute (ARI)

American Society of Mechanical Engineers (ASME)

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

Association of Home Appliance Manufacturers (AHAM)

Factory Mutual (FM)

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE. All equipment of a given type included in this section shall be furnished by or through a single manufacturer or as specified on the schedules. Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Owner and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work. All rotating parts of equipment shall be dynamically balanced at the factory.

1.6 DELIVERY, STORAGE AND HANDLING. Shipping, handling and storage are detailed in the Master Specification Section 01180.

Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

All equipment shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

Instructions for the servicing and startup of equipment in long term prolonged storage shall accompany each item.

All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.7 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts and shall meet the requirements of Sections 01180.

Furnish all special tools required for normal operation and proper servicing of the equipment. Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:

One complete set of drive belts for each piece of belt driven equipment

One complete shaft seal for all fans with shaft seals. Three full sets of air filters if not otherwise specified.

1.8 WARRANTY. In addition to the General Warranty, the equipment manufacturer shall warrant against parts and labor and any defect in material, construction, or performance of the Make Up Air Units and its components for a period of five (5) years from the date of acceptance for the Equipment, without any cost to the owner.

1.8.01 MAINTENANCE SERVICE. Concurrent with Parts and Labor Warranty, Manufacturer shall provide Five (5) year Full Maintenance program. Maintenance program shall include monthly service visits on each unit subject to the following:

Filter changes

Digital Performance Log

Check and/or replacement of belts

Check, Lubrication and/or replacement of fan bearing assemblies

Check and/or adjustment/replacement of electrical or control components

Check and/or adjustment/replacement of damper and operators

Check and/or adjustment/replacement of cabinetry seals, latches, panels etc

Check and/or cleaning of interior unit and coil surfaces

The above at a minimum shall appear on a Monthly Maintenance Sheet for each unit. Verification of maintenance via this sheet shall bear Witness signature of DWSD representative and turned in monthly in hard copy and/or digital copy in quantities up to Five (5) sets as determined by the DWSD. Sheet and format to be approved by DWSD prior to commencement of Five (5) Year Program.

1.8.02 WARRANTY SUBMITTAL. Submit a Written warranty signed by manufacturer agreeing to repair, restore, or replace defective work and maintain as specified in this section, within the specified warranty period without any cost to the owner.

PART 2 - PRODUCTS

2.1 MAKE-UP AIR UNITS. Acceptable manufacturers shall be Rush Air or approved equal.

2.2 DESIGN AND CONSTRUCTION. In general, units shall be factory assembled, packaged industrial type with fan, heating section, filters, motorized intake dampers, access sections with hinged access doors, motor, starters, motor base, gas train, gas pressure reducing valve, controls, drive, drive guard and vibration isolators. Rooftop units shall be completely weather proof. All units as shown and specified shall be furnished by the same manufacturer. Units shall be designed to provide an integrated assembly and factory tested when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit. The equipment dimensions shall be coordinated to fit in the space allocated in the Mechanical Room. Support brackets or rails are to be provided with the floor- mounted unit. Units shall have all rotating components internally isolated from the main unit with vibration isolators and floor mounting rails.

2.2.01 Casings. The unit casing shall be 2” double wall constructed of 20 ga, 304 Stainless Steel for both inner and outer liner. Unit floor shall be double wall 14 ga, 304 Stainless Steel. In addition, Unit frame, unit coil frames and all structural components shall be constructed of 304 Stainless Steel. Removable panels and access doors shall be 2” double wall constructed utilizing 20ga 304 Stainless Steel for both inner and outer skins. Insulation: Insulation shall be 2” thick closed cell foam. All sections including, but not limited to, filter, spacers, access sections, fan cabinet, shall be insulated. Insulation shall be 25.4 mm (1-in) verify all English units dims provided mat faced or neoprene coated fiberglass liner, 24 kg/M3 (1-1/2 lb/ft3) minimum density, installed with stick clips and adhesives to prevent erosion of the insulation.

2.2.02 Fan Section. Fans shall be centrifugal cabinet fans with belt drives. Extended external lubrication fittings shall be provided. Drives shall be adjustable V-belt type, with motor mounted on an adjustable slide base.

Backward curved wheels shall be airfoil types.

All fans shall be statically and dynamically balanced before shipment. All fans shall be AMCA rated for sound and air performance.
Motor shall be energy efficient TEFC, with internal load protection.

Factory wired controls shall be provided in the unit control panel. Panel shall include all safety controls and interlocks, control devices and terminal strip for remote wired devices. Control type shall be as specified on the schedules. Control voltage shall not exceed 120 Volt.

Makeup AHU’s shall utilize SWSI plenum style fans for supply air. Fans shall be constructed of 304 stainless steel. Fans performance shall be as scheduled. Fan Bearings shall be rated for L10 at 200000. Fan housing shall be vibration isolated.

2.2.03 Filters. Filter Box shall have tracks for the specified filter types, to allow filter replacement from either side. Sealing material shall be provided at tracks and ends to prevent air by-passing the filters.

Disposable Filters shall be framed filters, 50.8 mm (2-in) thickness as scheduled. Filter pressure drop for clean filters at 91 M\min (300 fpm) face velocity shall be 0.15-in wg for 50.8 mm (2-in) thick filters. Filter shall have 30 to 35 percent efficiency on ASHRAE Test Standard 52. Manufacturers and type shall be American Air Filter Co., AmAir 300X; Farr Co., 30/30 Disposable; Cambridge, Aeroplate or equal.

A total of three complete sets of filter media shall be provided for each unit.

For all types of filters, each filter section shall be provided with a magnehelic type gauge to indicate static pressure across the filter. Where more than one filter is used in series, each filter shall be provided with its own gauge. Where a control panel is provided gauges shall be mounted in the control panel.
2.2.04 Unit Control Panel. Remote panels shall include all stand alone DDC controls, and all safety controls and interlocks, heavy duty fused visible break, disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other Sections and on the Drawings. Control voltage shall not exceed 120 Volts. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door. Provide hardware and software as required to monitor with
remote building central DDC management system. Remote LCD display shall show lights for dirty filter, alarm, fan on/off, air temperature heat on/off etc.

All air handling control devices shall be compatible with control devices supplied under Section 15950 by the successful Temperature Control Contractor Division 15. The Make-up Air Unit Manufacturer shall coordinate with the Control and Mechanical contractors.

For self-contained package units, split systems and fuel burning units, factory wired control panel shall be furnished and mounted on the unit. Panels shall include all controls required in other sections, and all safety controls and interlocks, heavy duty fused visible break, disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other Sections and on the Drawings. Control voltage shall not exceed 120V. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door.

Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

NEMA 12 for indoor locations.

2.2.05 Accessories. Dampers shall be opposed blade type with blades mounted on 1/2-in minimum steel rods. Dampers shall be provided with low friction bushings and edge gaskets to reduce air leakage. Blades shall be sectionalized to limit unsupported blade length and warping at full system fan static pressures. Maximum damper blade width shall not exceed 6-in.

Provide top discharge section for air discharge.

Access sections shall have hinged doors for servicing.

Provide smoke detector, low and high temperature stats with additional contacts and accessories.
Provide airflow sensing switch to prove airflow and set visual and audible alarm in case of failure.

2.3 TESTING. Factory performance testing shall be provided using the governing standards of ARI, ASHRAE and SMACNA. These tests will be performed with the option of witnessing by the owner or owner's representative. Complete test procedure must be submitted for approval prior to testing. Approved testing procedures may then be scheduled. Run test will include but not limited to Air flow. Energy consumption, largest panel deflection test, per SMACNA and component verification (match components to submittal data).

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment shall be installed in accordance with manufacturer's recommendation. Provide piping and ductwork connections in accordance with the requirements of the other related Sections. Wire and install any equipment shipped loose for field installation.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

When units are shipped disassembled, field connect all sections including wiring together as shown on the Drawings to form single air handling unit. Seal all joints with gaskets and/or sealants.

Do not operate equipment without filters. Do not run equipment with dirty filter pressure drop more than twice clean filter pressure drop. A total of three complete sets of filters shall be provided. The first set is to be installed for start-up, test and balancing. The second set shall be installed after final cleanup and acceptance by the Owner. The third set shall be turned over to the Owner as a spare.

The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

Install unit level and plumb, maintaining manufacturer's recommended clearances and tolerances.

Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 Section "Joint Sealants."

Install wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

Provide necessary supports to accommodate weight of unit. Supports shall be epoxy coated to withstand corrosion. Provide vibration isolation fittings.

3.2 CONNECTIONS. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls. Ground equipment according to Division 16 Section "Grounding and Bonding."

End of Section

SECTION 15880

AIR DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of air distribution equipment, coils, fans, ductwork, duct mounted devices, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements. Fans shall be UL listed.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, ductwork, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.3.05 Ductwork. As required, ductwork shall be identified with nameplates as specified herein, or stenciled painting as specified in Master Specification Section 09900, Painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section

01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Central Station Air Handling Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Coil capacities and velocities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower (kW), static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least five different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Makeup Air Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Burner or heating coil capacities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least five different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Fans

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least three different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Schematic control wiring diagrams showing multiline wiring for the unit and all interconnecting devices. Wiring diagrams shall be detailed to the degree required for field construction, with all terminals identified.

Equipment

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Sheet Metal Fabrication Drawings

Duct layout drawings indicating shop fabricated sections and dimensions.

Pressure and seal classifications.

Access panel and door construction, sizes, and locations.

Duct sealant, adhesive, gasket, and tape information.

Coatings.

Ductwork materials.

Coatings

Name of manufacturer.

Coating type.

Chemical resistance data.

Temperature range data.

Surface preparation and application data.

Film thickness per coat.

Drying and curing time.

Color.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower (kW) rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

Adjustable Frequency Drive

Type and model.

Name of manufacturer.

Operating speed range, rpm.

Rated bhp (kW) at maximum speed.

Efficiency at maximum speed, percent.

Maximum heat output, BTUH (kW).

Speed at maximum heat output, rpm.

Dimensions and net weight of complete panel.

Catalog and data sheets on all components.

Electrical schematics and wiring diagrams.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4.03 Samples. Samples of protective coatings for equipment as required shall be submitted to Engineer for approval. The samples shall be at least 3 inches by 3 inches (75 mm by 75 mm) in size, and shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.5 QUALITY ASSURANCE.

Central station air handling units shall be certified in accordance with ARI 430.

Central station air handling unit coil capacities, pressure drops, and selection procedures shall be certified in accordance with ARI 410.

Electric heating coils shall comply with the National Electrical Code.

Direct fired makeup air units shall be independently certified to meet ANSI Z83.4.

Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the drawings, and shall be UL listed.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. One set of matched belts per unit and two sets of air filters per unit shall be furnished for the equipment.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

1.8 FRP DUCTWORK REGULATORY REQUIREMENTS. Comply with NFPA No. 255 for flame spread rating of 25 or less. Comply with NBS-15p69 and ASTM D4097.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as indicated.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for topcoating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 CENTRAL STATION AIR HANDLING UNITS. Central station air handling units, denoted by the symbol "AHU" and an identifying number, shall be manufactured by McQuay, Trane, York, or approved equal. Each central station air handling unit shall be complete with all sections and components indicated on the drawings.

2.5.01 Casing. Central station air handling units shall be factory built and tested draw-through units. The units shall be constructed of properly braced and reinforced steel framework with G90 galvanized steel panels as needed for the operating pressures. Gasketed removable panels or doors shall be furnished to provide access to all internal parts and components. The unit shall be constructed such that removal of side panels will not affect the structural integrity of the unit.

The casing shall be of sectional construction, consisting of a fan section, a cooling coil section with a sloped drain pan, a heating coil section, a face and bypass damper section, a filter section, blender section, and an access/spacer section as indicated on the drawings. The cabinets and casing shall be provided with the manufacturer's standard galvanized finish. Where indicated in the schedules on the drawings, units shall be double wall construction. When a unit is indicated to have double wall construction, all sections shall be constructed with internal liners. Liners shall be constructed of at least 20 gage (0.91 mm) thickness galvanized steel.

Sloped drain pans shall extend under the entire cooling coil section and sufficiently past the coil to capture and collect any condensate carryover when the unit is operating within the specified conditions. The unit design shall not require a drain pan in any downstream section to contain coil condensate. The drain pan shall be accessible for inspection and cleaning. The drain pan shall be constructed of stainless steel cross broken and pitched (double sloped) to the drain connection. The drain pans shall be completely insulated.

The interior of the fan section, coil section, and accessory sections shall be insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density, cleanable blanket type fiberglass insulation securely fastened to the panels. Insulation shall meet the requirements of the NFPA.

2.5.02 Fan Section. The fans shall be of the double width, double inlet, multiblade type. Wheel type shall be as indicated in the schedules on the drawings. Fans shall be dynamically balanced and tested after being installed in the factory-assembled fan section. The maximum fan speed shall not exceed 80 percent of the first critical speed. The units shall have externally mounted grease lubricated bearings or lubrication fittings extended to the exterior fan casing, with copper tubing and grease fittings rigidly attached to the casing. The fan bearings shall be self-aligning, grease lubricated ball type with an average life (L50) of at least 200,000 hours.

Static pressure values indicated in the schedules on the drawings are external to the complete unit. Internal coil(s), face and bypass damper, filter, and fan housing losses are not included. A filter allowance of 0.35 inches water column (87 Pa) shall be used for 2 inch (50 mm) pleated filter losses and 0.80 inches water column (200 Pa) shall be used for extended surface air filter losses.

2-5.03 Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors and controls shall be as specified in the Electrical paragraph.

Central station air handling units with smaller than 10 horsepower (7.5 kW) motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower (7.5 kW) and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets. Belt drives shall be designed for 1.5 times the fan brake horsepower.

Where indicated in the schedules on the drawings to be explosionproof, central station air handling units shall be suitable for installation in an NEC Class I, Division 2, Group D area.

2.5.04 Coil Section. The cooling and heating coils required by the central station air handling units shall be manufactured by the same manufacturer as the air handling units. Cooling and heating coils shall conform to the requirements of the Coils paragraph. Coil headers and return bends shall be completely enclosed by the unit casing. Coil connections, vents, and drains shall extend outside the unit casing and shall be clearly labeled.

Central station air handling units with hydronic cooling coils shall be selected to limit cooling coil velocities to 550 feet per minute (2.8 m/s) at the design airflow unless otherwise indicated in the schedules on the drawings. Central station air handling units with hydronic heating coils shall be selected to limit the heating coil velocities to 750 feet per minute (3.8 m/s) at the design airflow unless otherwise indicated in the schedules on the drawings.

2.5.05 Filter Section. Filter sections for central station air handling units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 300 feet per minute (1.5 m/s) for pleated air filters or 500 feet per minute (2.5 m/s) for extended surface air filters at design conditions, unless otherwise indicated in the schedules on the drawings. Gasketed access doors shall be provided for removal of filters from either side of the section. The filter thickness shall be as indicated in the schedules on the drawings and shall conform to the Air Filters paragraph.

2.5.06 Face and Bypass Damper Section. Face and bypass damper sections for central station air handling units shall be of the internal or external type as indicated in the schedules on the drawings. The dampers shall be opposed blade, low leakage type arranged to match the heating coil face area with top bypass. The damper shall have a maximum leakage rate of 10 cubic feet per minute per square foot at 4 inches water column (0.05 m^3/s per m^2).

2.5.07 Air Blender Section. Air blender sections for central station air handling units shall be factory installed within the unit. Air blenders shall be fixed devices with suitable clearances up and down stream of the blender for proper performance and uniform airflow through downstream components. The air blender shall be fabricated of 0.080 inch (2 mm) aluminum designed to mix the two airstreams to within ±6°F (3°C) of the theoretical mixed air temperature.

2.5.08 Accessories. Where indicated in the schedules on the drawings as variable volume with inlet vanes, central station air handling units shall be furnished with integral variable inlet vanes complete with a control ring, crank arms, a connecting shaft, and all interconnecting linkages required to provide a complete, properly operating unit.

Central station air handling units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage (1.9 mm) thick zinc-coated steel with a nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply and return air opening as indicated on the drawings. The curb shall be a minimum of 16 inches (400 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.6 COILS. Hydronic coils shall be of the drainable type with plugged vent and drain tappings.

Where indicated in the schedules on the drawings, coils shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.6.01 Hydronic Heating Coils. Heating coils, denoted by the symbol "HC" and an identifying number, shall be McQuay, Trane "Type W", York, or approved equal (installed in air handling equipment) or McQuay, Trane "Type ST", York, or approved equal (installed in ductwork).

Hydronic heating coils shall be extended surface type, arranged in a rectangle to fit the space available. The coils shall be designed for a working pressure of 200 psig (1380 kPa gauge) and shall have been hydrostatically tested and proved watertight at 200 psig (1380 kPa gauge). Coil casings shall be of galvanized or stainless steel and shall be rigidly braced. Coil headers shall be constructed of cast iron or a nonferrous material. Coil tubes shall be at least 0.024 inch (0.61 mm) thick, 5/8 inch

(16 mm) OD seamless copper with at least 0.006 inch (0.15 mm) thick aluminum fins mechanically bonded to the tubes. Seals shall be provided at top, bottom, and intermediate channels to minimize air bypassing the coil surface. Inlet and outlet connections shall be on the same end of the coils. Coils shall be removable from either side of the air handling unit.

The face velocity of a heating coil installed in ductwork shall not exceed 900 feet per minute (4.6 m/s) at maximum airflow.

2.6.02 Direct Expansion Cooling Coils. Direct expansion cooling coils, denoted by the symbol "CC" and an identifying number, shall be manufactured by McQuay, Trane, York, or approved equal.

Direct expansion cooling coils shall be multirow, 1/2 inch (13 mm) or 5/8 inch (16 mm) OD seamless copper tubes of 0.025 inch (0.64 mm) nominal wall thickness mechanically bonded to aluminum fins. Direct expansion cooling coils used in systems with multiple steps or circuits shall have interlaced circuitry. Refrigerant shall be distributed equally to multiple circuits by a pressure type distribution header with minimum pressure drop through the header and tubing. Coils shall be matched with the condensing unit or heat pump and shall be tested at 250 psig (1725 kPa gauge) prior to dehydration. Coils shall be purged and sealed with inert gas prior to shipment.

2.6.03 Hydronic Cooling Coils. Cooling coils, denoted by the symbol "CC" and an identifying number, shall be McQuay, Trane "Type W", York, or approved equal. Hydronic cooling coils shall be extended surface type, arranged in a rectangle to fit the space available. The coils shall be designed for a working pressure of 200 psig (1380 kPa gauge) and shall have been hydrostatically tested and proved watertight at a working pressure of 200 psig (1380 kPa gauge). Coil casings shall be constructed of galvanized steel and shall be rigidly braced. Coil headers shall be constructed of cast iron or nonferrous material. Coil tubes shall be at least 0.024 inch (0.61 mm) thick, 5/8 inch (16 mm) OD seamless copper with at least 0.006 inch (0.15 mm) thick aluminum fins mechanically bonded to the tubes. Cooling coils shall be rated for use with a fouling factor of 0.0005.

2.6.04 Electric Heating Coils. Electric heating coils, denoted by the symbol "HC" and an identifying number, shall be manufactured by Indeeco, Brasch, or approved equal. Electric heating coils shall be of open coil or finned tube zero clearance construction, as required, with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames with flanges suitable for fastening directly to the fan or coil and filter sections.

Bushings for open coils shall be ceramic and terminals shall be stainless steel. Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

A remote electric heating coil control panel shall be furnished and installed where indicated on the drawings. The electric heating coil control panel shall be completely factory wired and shall include disconnecting backup and safety contactors, transformers, fusing, and a disconnect switch. The heating coil terminal box shall include an automatic reset thermal cutout, a manually reset thermal cutout, a differential pressure airflow switch, and a pilot switch. The control panel shall be furnished with double doors.

The contactors shall be rated for 600 volt, 3 pole, UL listed, and shall have a life expectancy for 100,000 operations. The control transformer shall be built-in, industrial dry type, 480/120 volt sized to carry the full control system load. Primary and secondary windings shall be fused, and secondary windings shall have one lead grounded.

The heater shall be furnished with a silicone controlled rectifier (SCR) control unit mounted in the remote electric heating coil control panel. The SCR control unit shall be suitable for operation at temperatures of 32° to 132°F (0° to 55°C) and shall be solid-state, proportioning type, designed to modulate the heater output from 0 to 100 percent. The heater shall be controlled by a thermostat as indicated on the drawings. The SCR controller shall be compatible with the signal from the thermostat.

The electric heating coil output shall be as specified at 460 volts, 60 Hz, 3 phase. The heater elements shall be suitable for operation on 480 volt, 60 Hz, 3 phase power.

2.7 <u>MAKEUP AIR UNITS</u>. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be Hastings "SBD", Hartzell "GMC", Engineered Air "Series HE", or approved equal for direct fired units and Hastings "Counterflo", Engineered Air "Series DJ", or approved equal for indirect fired units as indicated in the schedules on the drawings. The makeup air units shall be constant volume, gas-fired type, and shall be completely assembled, wired, and flame tested at the factory.

Where indicated in the schedules on the drawings, makeup air units shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.7.01 <u>Construction</u>. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, a gas-fired burner section, a filter section, and, when located outdoors, an inlet hood with motorized control damper. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed and hinged doors shall be furnished to provide access to all internal components. An observation port shall be provided on the burner section for viewing the pilot and main flames.

The burner section shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density foil-faced fiberglass blanket insulation securely fastened to the panels. The fan and accessory sections shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density mat-faced cleanable fiberglass blanket insulation securely fastened to the panels. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. The insulation shall meet the requirements of NFPA.

Makeup air units installed outdoors shall be of weatherproof construction, with roof panels pitched for drainage. The roof panels shall be constructed with triple-break seams which overlap the side panels on all sides. All exterior joints shall be bolted or screwed with a gasket, or shall be welded, and shall be sealed weather tight.

Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air shall be mounted on the unit inlet. The hood shall include a two-positioned motorized control damper which opens when the unit is energized and closes when it is de-energized.

2.7.02 Fan Section. The makeup air units shall be equipped with centrifugal fans with forward-curved blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with motors greater than 15 horsepower (11.2 kW) and permanently lubricated or grease lubricated for units with 15 horsepower (11.2 kW) motors and smaller. Units with regreasable bearings shall have externally mounted, grease lubricated bearings or lubrication fittings extended to the exterior fan casing with aluminum or copper tubing and grease fittings rigidly attached to the casing.

Static pressure values indicated in the schedules are external to the complete unit. Internal burner or heat exchanger, filter, and fan housing losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for filter losses.

2.7.03 Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors and controls shall be as specified in the Electrical paragraph.

Makeup air units with smaller than 10 horsepower (7.5 kW) motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower (7.5 kW) and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.

2.7.04 Heating Section. The complete fuel burning assembly shall conform to the requirements of UL/ETL, FM, or IRI as required. The burner assembly and gas piping arrangement shall include, but not be limited to, pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valves, and electric modulating main gas valves. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment.

The unit shall be suitable for use with the gas pressure range as required.

2.7.04.01 Direct Fired. Burners shall be in-line type, suitable for use with natural or propane gas, as required, and shall be complete with stainless steel firing plates, cast iron gas feed, and stainless steel side plates for flame rods and ignition spark rods mounted in ceramic isolated bushings. The profile plates shall be adjustable and shall be sized to maintain the required velocity across the burner. The burners shall be capable of modulating turndown of 20 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff.

2.7.04.02 Indirect Fired. Burners shall be modulating power type suitable for use with natural or propane gas, as required. The burners shall be capable of modulating turndown of at least 8 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff. The heat exchanger shall be of 3 or 4 pass design consisting of 400 series stainless steel primary drum heat exchanger with multitube secondary heat exchanger.

2.7.05 Filter Section. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute (1.5 m/s) at design conditions unless otherwise indicated in the schedules on the drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch (50 mm) pleated type and shall conform to the Air Filters paragraph.

2.7.06 Controls. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, an electronic discharge air temperature sensor and controller, and a disconnect switch. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the drawings. The controls shall include controls to lock out the burner when the outside air temperature is above the controller setpoint.

A remote control station shall be furnished with the makeup air unit and located where indicated on the drawings. The control station shall allow for remote operation of the unit with a fan "On-Off" switch, a "Winter-Summer" switch, a supply temperature setpoint adjustment, and indicating lights for fan, heat, lockout, and dirty filters. Where indicated in the sequence of operations, a room override thermostat shall be mounted on the panel.

Unit mounted panels shall house adequately sized combination starters rated in accordance with NEMA standards, and dead-front 3 lock nonfused disconnect switches.

2.7.07 Accessories. Makeup air units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage (1.9 mm) thickness zinc-coated steel with a nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply air opening as indicated on the drawings. The curb shall be a minimum of 16 inches (400 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.8 FANS. Each fan shall be complete with an electric motor, a drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower (7.5 kW) motors and fixed sheaves for 10 horsepower (7.5 kW) and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

Fan drive motors and controls shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the drawings.

Fans indicated in the schedules on the drawings to be explosionproof shall be suitable for installation in a NEC Class I, Division 2, Group D environment.

The external static pressure values indicated in the schedules on the drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for pleated filter losses.

A solid-state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp (0.4 kW) to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

Where indicated in the schedules on the drawings, fans shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.8.01 Cabinet Fans. Cabinet fans, denoted by the symbol "CF" and an identifying number, shall be Greenheck "Model SP" or "Model CSP", Penn Ventilator, Loren Cook, or approved equal. Cabinet fans shall have steel, forward-curved, squirrel-cage type wheels. The fans shall be statically and dynamically balanced. Motors shall be open dripproof, PSC, with permanently lubricated ball bearings and internal thermal overload protection, and shall be suitable for use with the power supply indicated in the schedules on the drawings. Fan housings shall be fabricated of heavy gage carbon steel with welded seams and shall be acoustically lined and factory primed. Fans shall be installed in the configuration indicated on the drawings. A removable access panel or exhaust grille shall be provided on the bottom of each fan and a factory installed backdraft damper shall be provided on the fan discharge. Vibration isolator units and wall caps shall be provided for each fan as indicated in the schedules on the drawings.

2.8.02 Duct Fans. Duct fans, denoted by the symbol "DF" and an identifying number, shall be Greenheck "SQ", Penn Ventilator, Loren Cook, or approved equal. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.

The fan housing shall be square, constructed of aluminum or heavy gage steel as required, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch (25 mm) fiberglass duct liner.

Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, permanently sealed pillow block bearings.

Flexible wiring leads shall be provided from the fan motor to an external junction box and disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

2.8.03 Fume Hood Exhaust Fans. Fume hood exhaust fans and exhaust duct stackheads, denoted by the symbol "EF" and an identifying number, shall be manufactured by Kewaunee Scientific Equipment Corporation, or approved equal. Fume hood exhaust fans shall be of the single inlet, multiblade, flat or backward-inclined centrifugal type and shall be statically and dynamically balanced at the factory.

Fans shall be furnished with removable weather covers over the motors, drive shaft, and bearings. Each fan shall be furnished with vertical exhaust duct stackheads, and NEMA Type 3R disconnect switches.

Exhaust fan outlets shall consist of a duct stackhead and a transition section that fits directly onto the outlet of the exhaust fans. The duct stackhead shall be a zero pressure vertical stack weather cap designed to keep water out of the fan housing. Stackheads shall be rigidly supported as indicated on the drawings. The stackheads shall be fabricated of cold rolled steel, coated with a baked, chemical-resistant, synthetic resin finish, or fabricated of AISI Type 316 stainless steel. The exhaust stack shall be fabricated with all seams welded and ground smooth.

The fans shall be sized to fit in the space indicated on the drawings and shall be provided with vibration isolators, threaded 1/4 inch (6 mm) drain connections at the low point of the scrolls, and inlets suitable for attaching flexible connections to the fans.

The exhaust fans shall have welded housings and steel frames with a baked, chemical-resistant finish. Fan wheels shall be of steel and shall be coated with a baked, chemical-resistant finish, "Kem-FP" or approved equal.

2.8.04 Power Roof Ventilators. Power roof ventilators, denoted by the symbol "PRV" and an identifying number, shall be Greenheck "G" or "GB", Penn Ventilator "Domex", Loren Cook, or approved equal.

Power roof ventilators shall be centrifugal or propeller type, as indicated in the schedules on the drawings, and shall be statically and dynamically balanced for quiet, vibration-free operation. Each fan shall be complete with a weather hood, a safety disconnect switch mounted in the hood, a 1/2 inch (13 mm) mesh aluminum bird screen over all openings, and, where indicated in the schedules on the drawings, a backdraft damper. Fan housings shall be constructed of aluminum and shall have an aluminum base of the self-flashing type, suitable for mounting on the curbs indicated on the drawings.

2.8.05 Propeller Fans. Propeller fans, denoted by the symbol "PF" and an identifying number, shall be Greenheck "Model S" or "Model SC" for direct drive and "Model SB" or "Model SBC" for belt drive, Penn Ventilator, Loren Cook, or approved equal.

Propeller fans shall consist of a panel frame, a wire guard, a motor, and fan blades. Fan blades shall be steel or aluminum, as required. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.

When indicated in the schedules on the drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, backdraft damper, and weather hood with birdscreen.

2.8.06 Utility Fans. Utility fans, denoted by the symbol "UF" and an identifying number, shall be Greenheck "Model SWB", Penn Ventilator, Loren Cook, or approved equal.

Utility fans shall be multiblade, squirrel-cage type, with nonoverloading type blades. The fans shall be statically and dynamically balanced for quiet, vibration-free operation and shall be provided with vibration isolators. Fan inlets and outlets shall be provided with removable angles and bolts for attaching flexible connections. Fan housings shall be heavy gage steel, of all-welded construction and shall be shop coated with universal primer. Fan bearings shall be of the self-aligning, ball type.

2.8.07 Vaneaxial Fans. Vaneaxial fans, denoted by the symbol "VF" and an identifying number, shall be manufactured by Aerovent, Buffalo Forge, or approved equal. Vaneaxial fans shall have heavy gage steel housings with straightening vanes and adjustable blades. Fans shall be direct connected to an electric drive motor suitable for use with the power supply indicated in the schedules on the drawings. The fans shall be furnished with inlet bells, inlet and outlet screens, and support legs for mounting vertically or horizontally, as indicated in the drawings. The support legs shall be constructed of heavy steel plate attached to the fan housing and braced for rigidity. Each fan shall be equipped with access doors for blade adjustment and vibration isolators.

2.8.08 Wall Fans. Wall fans, denoted by the symbol "WF" and an identifying number, shall be Greenheck "Model GW" or "Model GWB", Penn Ventilator, Loren Cook, or approved equal. Wall fans shall be suitable for sidewall installation; shall be direct or belt driven, centrifugal type, with aluminum wheels and housing, and a wheel guard located on the discharge side; and shall be statically and dynamically balanced at the factory. The fan motors shall be of adequate size to prevent overloading when operating at the specified capacity and shall be suitable for use with the power supply indicated in the schedules on the drawings.

2.8.09 FRP Fans. Fans to be used in FRP applications shall be as manufactured by Plasticair, or approved equal.

2.9 ROOF HOODS. Roof hoods, denoted by the symbol "RH" and an identifying number, shall be Greenheck "Model FHI" or "FHR", Penn Ventilator, Loren Cook, or approved equal.

Roof hoods shall be suitable for air intake or exhaust and shall have throat dimensions as indicated in the schedules on the drawings. The roof hood assembly shall be constructed of galvanized steel or aluminum. Each roof hood shall be complete with a weather hood, a 1/2 inch (13 mm) mesh aluminum or galvanized bird screen over all openings, and a mounting base suitable for installation on a curb as indicated on the drawings.

Where indicated in the schedules on the drawings, roof hoods shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.10 AIR TERMINAL UNITS. Air terminal units shall include a sheet metal casing, volume dampers, an air volume sensing device, actuators, acoustical lining, sound baffles and accessory controls. The actuators type shall be as required. The acoustical lining shall conform to UL-181 and NFPA-90A. Enclosures of terminal units shall be constructed of galvanized steel not lighter than 22 gage (0.76 mm) thickness or aluminum sheet not lighter than 18 gage (1.21 mm) thickness. Single or multiple discharge outlets shall be provided as indicated on the drawings.

Terminal units shall be pressure independent and shall maintain a calibrated set or varying airflow rates with varying inlet static pressures. Unit air volume shall be factory preset and shall be readily field adjustable without special tools. Pressure losses through the unit at maximum flow rate shall not exceed the values indicated in the schedules on the drawings.

Acoustic performance of the terminal units shall be based upon units tested in accordance with ARI 880. Certified discharge and radiated sound power data for the units giving dB referenced to 10^{-12} watts in each of the octave bands shall be included with the air terminal unit submittal. Discharge sound power shall be shown for a pressure range from minimum up to the inlet static pressure as required. Radiated sound shall be indicated without allowance for ceiling absorption.

2.10.01 Coils. Heating water coils shall be furnished and installed where indicated on the drawings. The coils shall be fin-and-tube type, constructed of seamless copper tubes with copper or aluminum fins mechanically bonded or soldered to the tubes. Casing and tube support sheets shall be 16 gage (1.52 mm) thickness or 0.0635 inch (1.6 mm), galvanized steel, formed to provide structural strength. Each coil shall be designed for 150 psig (1035 kPa gauge) working pressure and shall be tested at an air pressure not less than 250 psig (1725 kPa gauge).

Electric resistance heating coils shall be duct-mounted type consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Electric duct heaters shall meet UL requirements and shall be provided with a built-in or surface-mounted high-limit thermostat. Electric duct heaters for use with fan-powered air terminal units shall be interlocked electrically so that heaters cannot be energized unless the fan is running.

2.10.02 Controls. Unit operators and controls shall be provided by the temperature controls supplier and shall be factory-installed by the air terminal unit manufacturer. The air terminal units will receive a control signal from the temperature control system and shall be furnished with controls to provide proper system operation. Controls shall include an automatic changeover control when heating and cooling air is supplied to the unit. The signal will modulate the primary air valve and the heating output as described in the sequence of operation.

2.10.03 Air Terminal Units - Single Duct. Single duct air terminal units, denoted by the symbol "ATS" and an identifying number, shall be Price, Environmental Technologies "Model SDR", Titus, or approved equal.

Constant volume, single duct terminal units shall be equipped with a mechanical or pneumatic constant volume regulator. The units shall control air volume within ±5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 0.50 to 6 inch wc (0.12 to 1.5 kPa).

Variable volume, single duct, low pressure terminal units shall be provided with a calibrated air volume sensing device, an air valve or damper, an actuator, and accessory relays. External differential pressure taps (separate from the control pressure taps) shall be provided for air flow measurement with a 0 to 1 inch wc (0 to 0.25 kPa) range. Unit volume controller shall be normally open or closed, as required, upon loss of the control signal.

2.10.04 Air Terminal Units - Fan Powered. Fan powered air terminal units, denoted by the symbol "ATF" and an identifying number, shall be Price, Environmental Technologies "Model VVF-II", Titus, or approved equal.

Variable volume, single duct, low pressure, fan-powered terminal units shall be provided with a calibrated air volume sensing device, an air valve or damper, an actuator, a fan and motor, and accessory relays. The units shall control primary air volume to within ±5 percent of each air set point as determined by the thermostat with variations in inlet pressure 0.5 to 6 inches wc (0.12 to 1.5 kPa). The unit fan shall be centrifugal, direct-driven, double-inlet type, with forward curved blades. The fan motor shall be permanently lubricated, permanent split-capacitor type. The fan speed shall be controlled by a solid-state speed controller to balance the fan airflow rate to the specified rates. The fan/motor assembly shall be isolated from the casing to minimize transmission of vibration. The fan control shall be factory furnished and wired into the terminal unit's control system. A factory-mounted pressure switch shall be furnished to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.11 DAMPERS.

2.11.01 Backdraft Dampers. Backdraft dampers, denoted by the symbol "BDD", shall be Arrow United Industries "Type 655", Ruskin "BD6", or approved equal. Backdraft dampers shall be constructed with a 1 by 4 inch by 0.081 inch thick (25 by 100 mm by 2 mm) extruded aluminum frame. Blades shall be of 0.081 inch (2 mm) aluminum, with silicone rubber seals on the edges, and with aluminum shafts and ball bearings.

2.11.02 Control Dampers. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet (2.3 m^2) or with any dimension exceeding 48 inches (1200 mm) shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit.

Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

Control dampers shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.11.02.01 Duct Mounted Control Dampers. Control dampers and face bypass dampers mounted in ductwork and equipment curbs shall be Arrow United Industries "Type AFD-20", Ruskin "CD-50", or approved equal. The damper frames shall be constructed of 5 inch (125 mm) Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch (150 mm) wide airfoil-shaped extruded aluminum.

Control dampers denoted on the drawings to be face and bypass dampers shall be vertically arranged. The face damper dimensions shall be coordinated with the heating coil dimensions. The bypass area shall be half the area of the face damper. Face and bypass damper submittals shall indicate coil size, face dimensions, and bypass dimensions.

2.11.02.02 Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Ruskin "CD-40", Arrow United Industries "Type AFD-20", or approved equal. Control damper frames shall be constructed of 4 by 1 inch (100 by 25 mm) 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch (100 mm) wide airfoil-shaped extruded aluminum.

2.11.02.03 Round Control Dampers. Round control dampers shall be Arrow United Industries "Type 70, 75, or 80", or approved equal. The damper frames and blades shall be constructed of the material as required.

2.11.03 Fire Dampers. Fire dampers, denoted by the symbol "FD", installed in partitions having a fire resistance rating of less than 3 hours shall be Air Balance Inc. "Model D19", Ruskin "Model DIBD2", or approved equal. Fire dampers installed in partitions having a fire resistance rating of 3 hours or more shall be Air Balance Inc. "Model D39", Ruskin "Model DIBD23", or approved equal. Fire dampers shall be style "B" for ducted and style "A" for non-ducted applications unless otherwise indicated on the drawings.

Dampers shall have a 5 inch (125 mm) wide galvanized steel channel frame, galvanized steel interlocking blades, stainless steel closure springs and latches, 165°F (74°C) fusible links, and a 20 gage (0.91 mm) thickness galvanized steel housing. Factory fabricated sleeves and mounting angles shall be furnished for each damper for mounting as indicated on the drawings. Fire dampers shall be rated in accordance with UL-555 for use in dynamic systems.

2.11.04 Smoke Dampers. Smoke dampers, denoted by the symbol "SCD" and an identifying number, shall be Air Balance Inc. "Series S", Ruskin, or approved equal. The damper leakage class shall be as required.

Damper frames shall be fabricated of 16 gage (1.52 mm) thickness, 5 inch by 1 inch (125 by 25 mm) galvanized steel channel and shall be sized to fit the ductwork as indicated on the drawings. Blades shall be parallel, 16 gage (1.52 mm) thickness galvanized steel, and shall be furnished with blade and jamb seals. Smoke dampers shall meet all applicable provisions of UL-555S and shall bear the UL label.

Axles and control shafts shall be of 1/2 inch (13 mm) plated steel, with oil impregnated bronze bearings. Linkages shall be concealed and shall be located outside the airstream.

2.11.05 Combination Smoke/Fire Dampers. Combination smoke/fire dampers, denoted by the symbol "SFD" and an identifying number, shall be Air Balance Inc. "Model FS2", Ruskin, or approved equal.

Combination smoke/fire damper frames shall be fabricated of a 16 gage (1.52 mm) thickness, 5-1/2 by 7/8 inch (140 by 22 mm) galvanized steel channel, interlocking 16 gage (1.52 mm) thickness galvanized steel blades, and an 18 gage (1.21 mm) thickness galvanized steel sleeve. The sleeve shall be at least 6 inches (150 mm) longer than the thickness of the wall or floor in which the damper is installed. Bearings shall be oil-impregnated bronze. Blade edge seals shall be high-temperature silicone rubber.

Each damper shall be provided with a matching UL-approved, factory installed electric actuator with 165°F (74°C) thermal disc. The actuator shall be installed for power-open/spring-return (fail closed) operation. The actuator shall be suitable for 120 volt single phase power supply and shall be rated for a temperature of 250°F (121°C).

Combination smoke/fire dampers and actuators shall meet all applicable provisions of UL-555 and shall bear the UL label. Dampers shall be rated 1-1/2 hour, leakage class II, and temperature class of 250°F (121°C).

2.11.06 Volume Control Dampers. Volume control dampers shall be denoted by the symbol "VCD". Volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD", Ruskin "Model MDRS25", or approved equal. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770", Ruskin "Model MD35", or approved equal.

Rectangular volume control dampers shall be fabricated of 16 gage (1.52 mm) thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch (100 mm or 125 mm by 25 mm) channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch (178 mm) long, 22 gage (0.76 mm) thickness frame, and a minimum 20 gage (0.91 mm) thickness circular blade.

The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

2.12 DAMPER OPERATORS. The damper operators shall be direct coupled or linkage type. Where linkage type operators are used, each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

Each operator shall have sufficient torque to operate the connected control damper area. Each damper operator shall have at least a 50 inch-pound (5.6 N-m) normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators shall be furnished to produce the normal running torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the drawings. Face dampers shall fail to the closed position and bypass dampers to the open position.

Where damper operators are installed in explosionproof rated areas indicated on the drawings, the operators shall be furnished and installed in explosionproof housings suitable for installation in an NEC Class I, Division 2, Group D area. Where damper operators are installed outdoors, the operators shall be furnished and installed in weathertight enclosures.

2.12.01 Electric Damper Operators. The electric damper operators shall be two-position or modulating type, as indicated in the sequence of operation or schedules on the drawings.

2.12.01.01 Modulating Electric Damper Operators. Modulating electric damper operators shall be Honeywell "Model M9185", or approved equal. Modulating electric damper operators in hazardous areas shall be installed in Honeywell "ES-650-118" explosionproof housing, or approved equal.

Modulating electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch (9.5 mm) square, double-ended drive shaft.

Damper operators shall be electrically operated, reversing, proportional operators with spring return, and internal single pole-double throw auxiliary switch rated 5 amperes at 120 volts ac.

Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers where required, shall be factory wired to the damper operator and installed in a NEMA Type 1 enclosure fastened to the motor housing.

2.12.01.02 Two-Position Electric Damper Operators. Two-position direct coupled electric damper operators shall be Belimo "NF120-S", Honeywell "ML4195", Johnson Controls, or approved equal. Linkage type electric damper operators shall be Honeywell "Model M4185", Johnson Controls "Model M100", or approved equal. Two-position electric damper operators in hazardous areas shall be installed in explosion proof housings.

Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA Type 1 enclosure fastened to the motor housing.

a. Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable. The operators shall be suitable for direct mounting to shafts up to 1 inch (25 mm) and shall be complete with mounting brackets and damper position indicator.

b. Linkage type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch (9.5 mm) square, double-ended drive shaft.

2.12.02 Pneumatic Damper Operators. The pneumatic damper operators shall be two-position or modulating type as indicated on the drawings. Each operator shall be provided with factory-mounted pilot positioners.

2.12.02.01 Two-Position Pneumatic Damper Operators. Two-position pneumatic damper operators shall be housed in a die-cast aluminum case with a mounting flange. Pneumatic operators shall be piston type, with a 3/8 inch (9.5 mm) square, double-ended drive shaft.

Pneumatic operators shall have a spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac.

2.12.02.02 Modulating Pneumatic Damper Operators. Modulating pneumatic damper operators shall be housed in a die-cast aluminum case with a mounting flange. Pneumatic operators shall be piston type, with a 3/8 inch (9.5 mm) square, double-ended drive shaft.

Modulating pneumatic damper operators shall be reversing type.

2.13 AIR OUTLET AND INLET DEVICES. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, Titus, or approved equal. Air outlet and inlet devices shall be furnished and installed where indicated on the drawings.

Air outlet and inlet devices shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.13.01 Linear Diffusers. Linear diffusers shall be constructed of aluminum or steel as indicated in the schedules on the drawings. All linear supply diffusers shall have adjustable air pattern control.

2.13.02 Ceiling Diffusers. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the drawings. Size, location, and direction of airflow shall be as indicated on the drawings.

2.13.03 Registers and Grilles. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

2.14 FLEXIBLE CONNECTIONS. Flexible connections located indoors shall be Ventfabrics "Ventglas", or approved equal. Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon", or approved equal.

Ductwork connections to the air handling equipment, and where indicated on the drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches (76 mm) of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20 to 180°F (-29 to 82°C) and shall weigh at least 27 ounces per square yard (915 g/m^2).

Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10 to 250°F (-23 to 121°C) and shall weigh at least 24 ounces per square yard (814 g/m^2).

2.15 AIR FILTRATION EQUIPMENT.

2.15.01 Pleated Air Filters. Pleated air filters shall be American Air Filter "AM-AIR 300X", Farr "30/30", or approved equal. Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have an average efficiency of 25 to 30 percent based on the ASHRAE 52.1 test method.

One inch (25 mm) filters shall have at least 14 pleats per linear foot (0.3 m) and at least 1.9 square feet of media per square foot of filter area (1.9 square meters per square meter). One inch (25 mm) filters shall have a maximum initial resistance of 0.10 inch wc at 300 feet per minute (0.02 kPa at 1.5 m/s).

Two inch (50 mm) filters shall have at least 12 pleats per linear foot (0.3 m) and at least 4.2 square feet of media per square foot of filter area. (4.2 square meters per square meter). Two inch (50 mm) filters shall have a maximum initial resistance of 0.13 inch wc at 300 feet per minute (0.03 kPa at 1.5 m/s).

2.15.02 Extended Surface Air Filters. Extended surface air filters shall be American Air Filter "VariCel II", Farr "Riga-Flo", or approved equal. Filters shall be of the disposable type with glass fiber or synthetic media pack. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. Extended surface air filters shall have an average efficiency of 60 to 65 percent based on the ASHRAE 52.1 test method. Filters shall have a maximum initial resistance of 0.40 inch wc at 500 feet per minute (0.10 kPa at 2.5 m/s).

2.15.03 Side Access Filter Housings. Side access filter housings shall be American Air Filter "Access Air", Farr "Model 4P Glide/Pack", or approved equal. Side access filter housings shall be single-stage, factory-fabricated of 16 gage (1.52 mm) thickness galvanized steel and shall be equipped with flanges for connection to the ductwork. Access doors shall be 16 gage (1.52 mm) thickness galvanized steel and shall be positioned to allow replacement of filters from either side of the housing. Filter housings and doors shall be insulated and of double-wall construction. Filter tracks shall be provided to accommodate nominal 2 inch (51 mm) thick disposable filters as described herein. Leakage at the rated airflow shall be less than 1 percent at a 3 inch wc (0.75 kPa) differential.

2.16 AIR FILTER MONITORING EQUIPMENT. Air filter monitoring equipment in the form of draft gauges and shaft power monitors shall be installed within all air distribution systems. The Contractor shall be responsible for equipment installation in accordance with the Manufacturers instructions. Furthermore, the Contractor will be responsible for start-up, testing, and operation and maintenance training of the Owner’s personnel.

2.16.01 Draft Gauges. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge", or approved equal.

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch (89 mm) diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140°F (-7 to 60°C), and a range of 0 to 1.0 inch wc (0.25 kPa), with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves.

2.16.02 Shaft Power Monitors. Shaft power monitors shall be Emotron “EL-FI M20” or approved equal.

Shaft power monitors shall at minimum include a system that is suitable for installation within the air filter electrical control panel. Shaft power monitors shall provide two (2) programmable alarm outputs for detecting overload and underload conditions. The system will provide user information via an on-board alpha-numeric display, which may be in the form of an LCD or LED. Alarm Status should be displayed. A DIN Rail mounted device is preferable. A panel mount kit should be available as an option. The system shall derive its power supply from the same source as that required for the air filter motor, i.e., the system must not require the provision of low voltage supplies, such as 110 VAC or 24 DC. To facilitate expanded plant wide monitoring and analysis, i.e., a SCADA system, the Air Filter Monitoring and Protection System must provide a self-powered, 2-wire, 4-20mA output signal that is proportional to the load on the air filter.

Shaft power monitors shall be installed no further than 25 radial feet (7.6 m) away from corresponding air units. The unit display shall be visible within the control panel or equipment setting. If multiple air handling units are to be installed, then all output signals and alarms relating to clogged or unclogged status shall be sent to a local PLC. This signal shall also be transferred to the main facility control panel. The system shall provide the user the ability to remotely reset an alarm condition that is initiated by the system. I/O connections shall be made in accordance with Master Specifications Section 17500, Programmable Logic Controllers.

2.17 SHEET METAL WORK. The ductwork, accessories, bracing, and supports shall be constructed of the material as required. Galvanized ductwork located in air conditioned spaces shall be constructed of G-60 or better lockforming quality in accordance with ASTM A653. All other galvanized ductwork shall be constructed of G-90 or better galvanized steel. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Plenums shall be constructed of reinforced 16 gage

(1.52 mm) thickness galvanized sheet metal.

Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch (25 mm).

Sheet metal fan boxes shall be fabricated with 12 gage (2.66 mm) thickness galvanized sheet metal skin and structural steel framing of sufficient strength to support the fan box and the fan mounted on the box. The framing shall be coated with a universal primer. All welds on galvanized metal shall be cleaned and coated with a zinc-rich paint. Drawings of the fan boxes shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Sheet metal ductwork for the laboratory exhaust systems shall be constructed of AISI Type 304 stainless steel with standard mill finish. Longitudinal seams and transverse joints shall be made with continuous welds. The welding procedure shall produce joints with corrosion resistance at least equal to that of the base material. Duct thickness shall be as needed for the welding procedure, but shall not be less than 22 gage (0.76 mm) thickness. Flanged connections shall be provided at all equipment and damper connections, and at intervals not more than 10 feet (3 m) as measured along the centerline of the duct. Flanged joints shall be provided with 1/8 inch (3.2 mm) thick viton gaskets suitable for temperatures up to 250°F (121°C).

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

Where indicated on the drawings, ductwork and accessories shall be given a protective coating resistant to the corrosive atmosphere.

2.18 DUCT INSULATION. Interior duct liner shall be Knauf "Duct Liner E M", CertainTeed "ToughGard R", Schuller "Permacote-Linacoustic", or approved equal.

Interior duct liner shall be 1-1/2 pound per cubic foot (24 kg/m^3) density, spray coated duct liner with an "R" value of at least 3.6 ft^2·hr· °F/BTU (0.63 m^2· C/W) per inch (25 mm) thickness. The insulation shall be suitable for temperatures up to 250°F (121°C) and shall have at least a 0.55 NRC per 1 inch (25 mm) thickness. The insulation shall conform to ASTM C1071.

2.19 FLEXIBLE DUCT AND TAKEOFFS. Flexible duct shall be Flexmaster "Type 9", Flexible Technologies "Thermaflex Type G-KM", or approved equal. Takeoffs shall be Buckley Air Products "Air-Tite Bellmouth BM-D", or approved equal.

Flexible duct shall be a galvanized or vinyl-coated spring steel helix, bonded to a polymer liner, and wrapped with glass fiber insulation suitable for use in heating and cooling systems. The insulation shall provide an "R" value of at least 4.2 $ft^2 \cdot hr \cdot$ °F/BTU (0.74 $m^2 \cdot$ C/W). The outer jacket shall be a vapor barrier of fire retardant polyethelene or polyolefin material. The flexible duct shall be listed under UL 181 as Class 1 flexible air duct and shall comply with the latest edition of NFPA 90A.

Takeoffs for the flexible duct shall be bellmouth type manufactured of galvanized steel with a neoprene gasket and predrilled holes. Each takeoff shall be equipped with a balance damper constructed of 26 gage (0.45 mm) thickness galvanized steel. Scoops or other obstructions in the main duct will not be acceptable.

2.20 ACCESS DOORS. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2.21 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.22 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2-22.01 Adjustable Frequency Drives. Adjustable frequency drives (AFD) shall be provided as indicated in the schedules on the drawings. Each adjustable frequency drive shall be coordinated with the requirements of the driven equipment. Particular attention shall be directed toward the driven equipment torque requirements.

The equipment supplier shall be responsible for coordinating the AFD with the driven equipment to assure compatibility between the drive and motor. All equipment shall be derated as recommended by the AFD and motor manufacturers for reduced speed operation with an adjustable frequency controller.

Each AFD shall be pulse-width modulated type and shall produce an adjustable ac voltage/frequency output. Each AFD shall maintain a minimum displacement power factor of 0.95 over the entire speed range, and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

Each AFD shall be equipped with an input line reactor and a full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a fixed dc voltage.

The AFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The AFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. Each AFD shall be configurable for automatic and manual reset and shall have an adjustable carrier frequency to at least 16,000 Hz.

2.22.02 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor.

2.22.03 Safety Guards. All belt drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.22.04 Electric Motors. Motors furnished with equipment shall meet the following requirements.

a. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

b. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

c. Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

d. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

e. To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

f. Designed for full voltage starting.

g. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

h. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

i. Bearings shall be either oil or grease lubricated.

j Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feed and chemical handling

locations.

4. Equipment operating in wet or dust-laden locations.

k. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

l. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

m. Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase.
Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

n. All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

o. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

p. Motors to be used with adjustable frequency drives shall be rated for inverted service.

2.23 SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

2.24 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in pounds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

2.25 FRP DUCTWORK.

2.25.01 Material. Fiberglass reinforced polyester resin; complying with ASTM C581. Do not add thixotropic agent to resin.

2.25.02 Corrosion Liner. Consists of one “C” veil and one chopped strand mat (1-1/2 ounces) or one layer of chopped strand prior to filament winding. Provide minimum 30 mil thickness.

2.25.03 Duct Wall Thickness. Minimum 1/4 inch.

2.25.04 Fittings. Provide smooth bends or internal turning vanes at elbows, tees and at other changes in direction.

2.25.05 Suction Inlet. Provide suction inlet with vinyl coated screen; 50 percent free area.

2.25.06 Flanges. Comply with ASTM D4024 and PC15-69, Sections 3.4.7.1 to 3.4.7.5.

2.25.07 Fabrication. Comply with Voluntary Product Standard PS15-69, Sections 3.1.1 to 3.4.9. Fabricate for water drainage.

2.25.07.01 Visual Defects. Comply with ASTM D2563, Level II.

2.25.07.02 Exterior Coating. Comply with PS-15-69, Section 3.3.3.1.

2.25.07.03 Duct Deflection Rectangular Duct. Rectangular Duct: Not to exceed 2 percent of the width of the side at a test vacuum pressure of 6 inch wc.

2.25.07.04 Duct Deflection Round Duct. Not to exceed 2 percent or “S” of duct diameter under an impolsed hoop (point) loading of 550 pounds.

2.25.08 Duct Supports. Provide at least every 5 feet; fabricated of galvanized steel.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3.2.02 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of topcoats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Air Handling Units. Flexible connections shall not be in tension when the fans are operating.

3.3.02 Coils. Hydronic coils shall be installed level, except for drainable coils which shall be installed with a pitch toward the drain end of the coil. Hydronic coil piping shall be arranged with the supply connection at the bottom of the coil and the return connection on the top. The water supply connection shall be toward the leaving side of the air coil for counterflow arrangement.

A sight glass shall be installed in the liquid line adjacent to each refrigerant coil. Where air handling units are installed on vibration isolators, flexible connectors shall be installed in the coil piping.

3.3.03 Makeup Air Units. Flexible connections shall not be in tension when the fans are operating.

3.3.04 Fans. Flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

Power roof ventilators shall be secured with corrosion resistant lag screws to the roof curb.

3.3.05 Roof Hoods. Roof hoods shall be secured with corrosion resistant lag screws to the roof curb.

3.3.06 Air Terminal Units. Each air terminal unit shall be individually supported from the building structure.

3.3.07 Dampers. Fire, smoke, and combination fire/smoke dampers and smoke dampers shall be furnished and installed where indicated on the drawings and as specified by NFPA 90A. All dampers shall be installed in accordance with the manufacturer's UL installation instructions.

Fire dampers shall be installed square and free from racking with blades horizontal. Fire damper frames shall not be compressed or stretched into duct or opening and shall be handled using the sleeve or frame. Where multiple section assemblies are needed, bracing shall be installed to support fire damper weight and to hold assembly against system pressure.

Smoke dampers shall be mounted with the damper blades running horizontal. A duct mounted access door shall be located on the jackshaft side of each damper.

3.3.08 Damper Operators. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

3.3.09 Air Outlet and Inlet Devices. Diffusers with balance dampers installed in the flexible duct takeoffs shall not have an opposed blade damper mounted in the throat of the diffuser.

Ceiling mounted air terminals or services weighing 20 pounds (89 N) shall be supported directly from the structure.

3.3.10 Draft Gauges. Draft gauges for filters located more than 8 feet (2.4 m) above the finished floor shall be mounted on the nearest wall, 5.5 feet (1.7 m) above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

3.3.11 Sheet Metal Work. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards. The locations, arrangement, and sizes of ductwork shall be as indicated on the drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

Ductwork shall be constructed and installed in accordance with the drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet (2.4 m) above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch (200 mm) lighting allowance between the ceiling and the bottom of the ductwork.

In vertical ducts with a closed bottom which terminate less than 24 inches (600 mm) above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch (12.5 mm) drain hole in the bottom of the duct.

Single-thickness turning vanes shall be installed in all turns with 45 degree or greater angles.

3.3.12 Duct Insulation. Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches (200 mm) on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

The following ducts shall be insulated with a 1 inch (25 mm) thick interior duct liner unless otherwise indicated or indicated on the drawings to be wrapped:

Makeup or outside air ducts.

Air conditioning system supply and return ducts.

Other ducts where indicated on the drawings.

3.3.13 <u>Flexible Duct and Takeoffs</u>. The length of the flexible ductwork shall not exceed 8 feet (2.4 m). All support saddles for flexible duct shall be a minimum of 6 inches (150 mm) wide.

3.3.14 <u>Access Doors</u>. Airtight access doors shall be provided for inspection of all control dampers, fire dampers, smoke dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches (200 mm) square for hand access, 18 inches (450 mm) for shoulder access, or as indicated on the drawings. Each access door shall be installed to open against the pressure in the duct.

Access doors at locations where smoke and fire dampers are installed shall be permanently identified on the exterior by a "Smoke Damper" or "Fire Damper" label with letters not less than 1/2 inches (12.5 mm) in height.

Access doors for fire dampers shall be located as close as possible to the damper, and be located so that the spring catch and fusible links are accessible when the damper is closed. Where the size of the duct permits, the minimum size access door shall be 18 inches by 18 inches (450 mm by 450 mm). For dampers that are too large to access from outside the duct, the door shall be a minimum of 24 inches by 18 inches (600 mm by 450 mm). Where possible, the access shall be located on the underside of the duct.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15890

ODOR CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the installation and furnishing of odor control systems Included, but not limited to, are the following concepts; carbon odor control vessels, grease filter/mist eliminators, FRP fans, fan acoustical enclosure units, interconnecting ductwork, anchorage devices, tools and spare parts.

1.2 GENERAL. Contractor shall provide all labor, materials, equipment and incidentals required to furnish and install new odor control system(s) for the wastewater collection and treatment facilities.

1.2.01 Coordination. Contractor shall be responsible for coordination of the design, fabrication, and installation of the odor control system shown on the drawings and specified herein. Contractor shall coordinate the installation of the items to comply with the requirements of the Work specified under this Section.

1.2.02 General Equipment Stipulations.
Obtain all equipment included in this Section from a single carbon odor equipment manufacturer, hereon referred as the Odor Control System Supplier (OCSS), regardless of the component manufacturer. The OCSS shall review and approve or shall prepare all shop Drawings and other submittals for all components furnished under this Section. All components shall be specifically designed for odor control services and shall be integrated into the overall system by the OCSS.

1.2.03 Governing Standards. Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:

ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
ASTM A194, Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure and High-Temperature Service.
ASTM C581, Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures.
ASTM C582-87, Standard Specification for Contact Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosions-Resistant Equipment.
ASTM D2563-87, Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
ASTM D2583-87, Standard Test method for Indentation Hardness of Rigid Plastics by Means of Barcol Impresser.
ASTM D2584-68, Standard Test Method for Ignition Loss of Cured Reinforced Resins.
ASTM D3299-88, Standard Specification for Filament-Wound Fiberglass

Reinforced Thermoset Resin Chemical Resistant Tanks.
ASTM4097-88, Standard Specification for Contact Molded, Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks.
ASTM E84, Standard Test Method for Surface Burning Characteristics for Building Materials.
American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
National Electric Code (NEC).
National Electrical Manufactures Association (NEMA).
National Fire Protection Association (NFPA).
Underwriters Laboratories, Inc. (UL).
National Bureau of Standards (NBS) Voluntary Product Standard PS 15-69 Custom Contact Molded Reinforced Polyester Chemical-Resistant Process Equipment.
Society of Plastics Industry (SPI) Standards of Recommended Practices for Shipping and Installation of Fiberglass Reinforced Plastic Pipe, Duct and Tanks.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Manufactures of carbon vessel, fan, fan enclosure, grease filter/mist elimination and ductwork shall have a minimum of 5 years of experience or producing substantially similar equipment, and shall be able to show evidence of at least 5 installations in satisfactory operations for at least 5 years in the United States.

1.3.02 Testing. Odor controls system shall be shop tested in accordance with Master Specifications Section 15990, Testing, Adjusting, and Balancing, unless otherwise specified herein.

1.3.03 Vessel shop test. Provide services of an Independent FRP Testing Inspector to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following; visual inspection to the requirement of ASTM C582 and ASTM D2563, Barcol Hardness measurements per ASTM D2583-87, acetone sensitivity test for all internal secondary bonds, glass content by ignitions loss on three cutouts per ASTM D2584, and Hydrostatic Leak Test on each vessel by filling to the top of vessel and allowing to stand for 2 hours with no visible leakage.

1.3.04 Fan Shop Test. Perform a shop test on each fan at each operating condition.

Running Test: record volume, static pressure, speed, efficiency, BHP and housing vibration.
Running time at each condition shall be a minimum of one hour
Data shall be continuously recorded

Test shall be conducted with the job motor

Acoustical test: Record octave band sound power levels (LW) IN/dB RE 10-12 W, from 63 to 8000Hz. Convert to sound pressure level dB on "A" weighted scale, at a distance of 5 ft.

Test all fans from a facility in succession.

Motor Shop Test. Each motor shall be given a complete shop test. Ship motor to the fan manufacturer following successful completion of shop tests. Test reports shall provide the following minimum information:

Starting Torque.
Efficiently at ½, ¾ and full load.
Power factor at ½, ¾ and full load.
Percent slip.
No load, running light, full load and locked rotor current.
Current balance check.
Test curves for current, voltage, brake horsepower and power factor.
Full load heat run.
Vibration check.
Temperature rises and results of dielectric tests.
Motor type and frame size.
Bearing type and lubrication medium.
Insulation and enclosure type.
Load sound pressure levels in dB on the A weighted scale at 5 feet from the motor fan end. Sound pressure levels shall be determined in accordance with the procedures of IEEE Standard 85.

1.3.05 Ductwork Shop Test. Provide services of an Independent FRP Testing Inspector to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following; visual inspection to the requirements of ASTM C582 and ASTM D2563, Level III, Barcol Hardness measurements per ASTM D2583, acetone sensitivity test for all internal secondary bonds and glass content by ignition loss on three counts per ASTM D2584. Repairs deemed Acceptable by Independent FRP Testing Inspector must be approved by Owner.

1.4 SUBMITTALS.

OCSS shall be responsible for preparing and reviewing submittals for all system components as specified in Section 1.3.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project

Submittals. Submit for approval; fabrication, assembly and installation diagrams, manufacturer's literature, illustrations, paint certifications, specifications and engineering data including dimensions, materials, size and weight of all components and complete assembly, setting drawings, templates, and directions, for the installation of anchor bolts and other anchorages, drawings showing plans and sections of the equipment to demonstrate proper coordinates between components, fabrication methods, assembly, accessories, installation details, and wiring diagrams. Description of surface preparation, shop printing and finish painting system and deviations of Contract Documents. Provisions shall be included to adequately ground the carbon bed. Manufacturer shall supply adequate submittal details to demonstrate that the carbon bed will be adequately electrically grounded. Odor Control System data shall include, but not limited to; detail product information on the control and layout drawings including locations of external wiring and piping connections and mounting, and panel wiring and piping diagrams including identification of external wiring connections.

1.4.02 Test Reports. Submit results of the required shop tests and a written field test report giving the results of required field tests.

1.4.03 Record Drawings Submit complete manuals including, copies of all shop drawings, test, reports, maintenance and data and schedules, description of operation, acceptable lubricants, and spare parts information. Operations and Maintenance data shall be submitted in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING
Deliver materials to the Site to insure uninterrupted progress of the Work. Deliver anchors bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to insure not to delay Work. Store all materials in a manner that will permit easy access for inspection and identification purposes. Keep steel members off the ground using pallets, platforms and other supports. Protect equipment including packaged materials from corrosion and deterioration. Odor control vessels shall be shipped empty and all interior components shall be shipped separately. Store mechanical equipment in covered storage off the ground to prevent condensation.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. The odor control vessel shall have the following performance specifications: Number of units, Size, Type, Bed depth, Bed velocity flow, Pressure drop, and Maximum head loss at the bed velocity flow per foot depth of packed bed.

2.2 CARBON ADSORPTION UNITS.

2.2.01 Acceptable Manufacturers. Provide odor control equipment as manufactured by one of the following: Calgon Carbon Corporation, U.S. Filter, Norit Americas, Inc., or Approved Equal

2.2.02 Activated Carbon. The activated carbon shall be virgin pelletized activated carbon, derived from bituminous coal. The activated carbon shall be suitable for the vapor phase adsorption of wastewater treatment odors. The activated carbon shall have the following specifications:

Iodine No., mg/g	1000 min
Butane Activity, weight % (per ASTM D 5742)	26 min
Hardness	95 min
Apparent Density, g/cc	0.46 – 0.49
Minimum Particle Density	3.7 mm to 4 mm pellet
H_2S Breakthrough Capacity (g H_2S removed/cc Carbon)*	0.30 min

Ignition Temperature, ^{o}C, minimum (per ASTM D 3466): 350

* The H_2S breakthrough capacity shall be determined using ASTM standard method D6646-01. Prior to testing, the test sample should be completely humidified by exposing the sample to a flow of humid air for at least 12 hours. Testing of 3.5 to 4 mm diameter pellets is accomplished by passing a moist (85% RH) stream of air containing 1 vol. % H_2S and the selected concentration of CO_2 through a 1.5 inch inner diameter tube with a 9" deep bed of closely packed carbon at a rate of 3,262 cc/min and monitoring to a 50 ppm H_2S breakthrough. The results are reported as grams of H_2S adsorbed per cc of carbon.

2.2.03 Odor Control Vessels Construction. Vessels shall either be contact-molded in accordance with ASTM D4097, Grade 1 or Type I, filament-wound in accordance with ASTM D3299-88, Grade 1. Portions of the vessel including joints, heads and nozzles shall be fabricated by contact molding. Contact molded laminates shall be in accordance with ASTM C582, Table 1. All laminate physical properties shall comply with requirements for laminate thickness of 3/8 inch and thicker.

All vessels shall be designed using a minimum structural safety factor of 10 to 1 for pressure and 5 to 1 for vacuum. Vessels shall have bottom knuckle reinforcement and be designed for hydrostatic head load 10-foot above the top of the inlet.

Vessel housing shall be designed for full bottom support and shall be provided with a minimum of four Type 316 stainless steel hold down lugs. All hold down lugs shall be designed to account for all anticipated loads and shall comply with local code requirements. Furnish all anchor bolts, nuts and washers which shall be Type 316 stainless steel.

The support system for carbon beds shall be as recommended by the odor control vessel supplier and approved by the Engineer. The carbon beds shall be individually supported on a polypropylene screen basket resting on each support system. The carbon bed screens and support systems shall be removable through access manways. The support system shall be a system of grating, beams and columns or equal. The support system shall be capable of withstanding a load of not less than 300 lbs./sq.ft with a deflection not greater than 1/4 –inch under any operating condition. All components of the support system shall be constructed of materials resistant to the chemical service conditions specified for corrosion. The carbon bed shall be provided with a molded fiberglass reinforced vinyl ester grating to act as a bed limiter for the lower bed. The grating shall be 1-inch thick by 2-inch by 2-inch square type to achieve a minimum free area of 75 percent. The grating shall cover the entire surface of the lower bed and shall be installed in sections that shall be removable through the access door. Cope bed limiter to match diameter of vessel. A fully seamed polypropylene screen sewn basket shall be provided to hold the activated carbon without fraying. All edges and seams shall have “piping” to reinforce the seams and edges to prevent fraying. The basket shall be of sufficient strength to hold the carbon without tearing.

2.2.04 <u>Resins</u>. Resins used in laminate shall be premium corrosion resistant and fire retardant brominated bisphenol. All vinylester resins are to achieve a 25 or less flame spread rating in accordance with NFPA 91. Provide products of one of the following manufacturers: Ashland Chemical Co. Hetron 992 FR with 3 % antimony trioxide, Dow Chemical Co. DeraKane 510A or 510C with 5 % antimony trioxide, Reichold, Dion 9300 FR with 5 % antimony trioxide, or approved equal.

All cut edges shall be sealed with a resin coating of the same resin as used in the fabrication. The resin shall contain paraffin.

2.2.05 R<u>einforcement</u>. Synthetic surfacing veil shall be Veil-Nexus 1012 (aperture) as manufactured by Burlington Industries. Chopped strand mat shall be Type E glass, minimum 1.5 ounces per square foot, with silane finish and styrene soluble binder. Continuous roving used in chopped gun shall be Type E glass. Woven roving shall be Type E glass, nominal 24 ounces per square yard, with a 4 by 5 weave and a silane type finish. Continuous roving used for filament winding shall be Type E glass with a silane type finish, with a nominal yield of at least 110 strand yards per pound. Glass content for filament wound layers shall be 55%-70%.

2.2.06 <u>Laminates</u>. Laminates shall consist of a corrosion resistant resin-rich inner surface, an interior corrosion barrier, an interior structural layer, and an exterior layer. Composition specified for inner surface and interior corrosion barrier is intended to achieve optimum chemical resistance. Corrosion resistant resin-rich inner surface shall be reinforced using a single aperture Nexus synthetic veil. Minimum resin-rich inner surface thickness shall be 10-20 mils. Thixotropic agents shall not be used for this service. Glass content of resin-rich inner surface shall be 10 % plus or minus 5 % by weight. Interior corrosion barrier shall be a minimum of 100 mils of Type E glass chopped strand mat to a total of 3 oz/sqft. The interior corrosion barrier shall be applied by either the hand laid up technique, filament winding or chopper gun. Chopper gun is only permitted if an automated process is used. Manual operation of chopper gun shall not be permitted. Glass content of interior corrosion barrier shall be 25 % plus or minus 5 % by weight.

Laminate Physical Properties:

Ultimate Tensile Strength (min.PSI) ASTM Method D638:	15,000
Modulus of Elasticity Procedure A of ASTM Method D790	10 x10
Flexural Strength – (min.PSI) ASTM Method D790	22,000
Average Glass content of Completed Tanks by Ignition (%)	45

Interior structural layer shall be of sufficient thickness to meet minimum thickness requirements specified. Glass reinforcements shall be in accordance with the appropriate standards of construction. Interior structural layer shall be fabricated using either the hand lay up, filament wound technique or approved chopper gun technique. Glass content of interior structural layer shall be 60 % plus or minus 5 % by weight. In no case shall total thickness of the interior structural layer be less than 0.50 inches. Exterior layer shall be reinforced using a single “A” glass veil with a layer of surfacing “Nexus” veil followed by a clear resin rich 10 mil thick coating similar to the inner surface. Topcoat shall be pigmented parafinated get-coat with ultraviolet inhibitors. The pigmentations shall be beige. There shall be no glass fibers exposed. Vessel wall shall be reinforced around all openings and connections.

2.2.07 <u>Curing</u>. Each vessel shall be given a BPO-DMA cure system to increase service life. In addition, interior of vessel shall be post-cured. Post cure shall consist of an FRP vessel wall cure temperature of at least 180° F for a minimum of 4 hours. Independent of exterior ambient fabrication shop temperature, the temperature inside the vessel may have to be elevated above 180° F. At no time shall the vessel wall temperature approach 90 % of the thermal distortion temperature for the resin used Barcol readings taken after the post-cure shall not be greater than 4 points less than the resin manufacturers published Barcol readings and in no case less than 35. Where steam is used in the post-cure, no steam shall impinge on the interior surface of the vessel of the inside of any nozzle. A steam sparge pipe projecting at least 12 inches beyond the interior surface of any nozzle and 12 inches away from any wall shall be used. During steam post-curing, the vessel shall be maintained at atmospheric pressure. Alternate curing methods may be submitted for the Engineers approval. Cobalt compounds shall not be used to accelerate curing of the FRP in any way.

2.2.08 Connections. All necessary connections for piping, instrumentation, sampling, and ductwork shall be provided as shown on Drawings or required. Suitable EPDM gaskets shall be provided. Two inch drain assembly with CPVC ball valve and 2 inch over flow drain with threaded coupling and plug. Each carbon bed shall have two 11/2 inch diameter sample probes adjacent to the carbon bed which shall extend a minimum 6 inches into the carbon bed. Probes shall be adequate to provide suitable extraction of carbon samples from the carbon bed and be non-binding. Probes shall extend outside the vessel wall and be blocked off with ball valves. One additional ¾ inch diameter sample probe shall be installed in each discharge stack and shall extend down and adjacent to the other probes. Probes and ball valve shall be of CPVC construction. Carbon adsorption unit manufacturer shall provide factory mounted pipe supports for outlet air sample ports, bottom drain connection, and 3-inch wide baffle ring around the interior circumference of each carbon bed. Flanges of air inlet, air outlet and access doors shall be manufactured by hand lay up method and shall conform to NBS-PS15-69; standard dimensions for bolting, but in no case shall the thickness be less than ¾ inch thick. Flange nozzles for piping connections shall conform to ASTM D3299, all nozzles up to and including 8-inch diameter shall be reinforced with blade type gussets. Flanges for piping connections shall be ANSI 150 lb dimensions. All flanges shall be pre-drilled. Flanges shall be checked for alignment, thickness and mating prior to shipment to field. Area on the back of all flanges around each bold hole shall be the diameter of a standard washer and shall be flat and parallel to flange face. This area shall be spot faced, if necessary, to meet this requirement.

2.2.09 Hatches. Access hatches shall be provided above top and bottom of main carbon bed sections to allow easy inspection, cleaning and maintenance of carbon. Support gratings and lower carbon bed limiter shall be removable through access hatches. All access hatches shall be in easily accessible locations and coordinated with all structural columns, structural wind bracing, ductwork and piping. All access hatches shall be corrosion resistant to acidic and basic cleaning solutions. Access hatches shall be outfitted with clear PVC, removable, corrosion resistant panels, all stainless steel type 316 hardware including nuts, washers, bolts and extruded silicon gaskets. Minimum size of access doors shall be 24-inches high by 30-inches wide by ½ inch thick with not less than 18 bold hold-down assemblies. Blind flanges and access hatch doors shall be same thickness and material as flanges to which they are attached. Tolerances and flatness shall be same as for flanges. Manways shall have word" CAUTION" stenciled on in 3-inch high red block style lettering.

2.2.10 Miscellaneous. Odor control vessels shall contain the following:

A grounding system as submitted under item 1.4, Submittals.

Lifting Lugs that shall be capable of withstanding weight of empty vessel with minimum safety factor of 5 to 1. A minimum of three lugs shall be furnished per vessel. Lifting lugs shall be Type 316 stainless steel and attached to vessel wall with hand lay-up laminate equal to or greater than the vessel wall thickness.

Mounting Lugs that are suitable for mounting electrical junction boxes. Mounting lugs shall be Type 316 stainless steel and attached to the vessel wall with hand lay-up laminate equal to or greater than the vessel wall thickness.

Odor control vessel exhaust stack and any other transition pieces required. These items shall be fiberglass, reinforced vinyl ester and furnished by the odor control vessel manufacturer. All fiberglass reinforced vinyl ester ductwork shall be as specified in this Section.

Carbon Sampling Device. A One grain thief sampling device shall be provided. The device shall be a fisher Scientific Model 14-208, or approved equal.

Hydrogen Sulfide Bed Monitor. Furnish a bed monitoring system to enable plant personnel to check for the presence of hydrogen sulfide at any sample port within the carbon bed. The monitor shall be sensitive to H_2S concentrations from 0.5 ppm to 20 ppm, and visually indicate that concentration range. The hydrogen sulfide bed monitor assembly shall provide means to detect H_2S levels with the carbon bed. The monitor shall include an adjustable flowmeter and lead acetate paper color indicating disk. The monitor shall have a fitting to attach to any carbon bed sampling port. The monitor shall be manufactured by the vessel manufacturer.

Differential Pressure Gage. Provide a photohelic differential pressure gage/switch at each carbon bed (two per vessel) to measure the differential pressure through each carbon bed through the entire vessel. Gages shall be the dial type with die cast aluminum, irridite dipped for corrosion resistance. The range shall be 0 - 20 inches water gage for odor control vessel and accuracy shall be 2 percent of scale. Switches for high and low set point shall be adjustable from knobs on gage face.

Quantity	2 per unit
Type	DPDT, Rated 10A @ 120VAC
Power requirements	120 VAC
Deadband	Maximum 1 percent of full scale
Enclosure	NEMA 4X

Manufacturer: Provide products one of the following, Dwyer Instrument, Incorporated Model 3000 series Photohelic Pressure Switch/Gage or approved equal.

2.3 FIBERGLASS REINFORCED PLASTIC FAN.

2.3.01 Manufacturer. Provide fans as manufactured by one of the following, New York Blower Company, The Ceilcote Company, Hartzell Fan, Inc., or approved equal.

2.3.02 Construction. Provide fiberglass reinforced plastic fire retardant fans with an epoxy coating to protect against ultraviolet degradation. Fans shall be installed, complete with motors, drives, guards and coatings of sufficient capacity for the duty required. Fans shall operate to draw odorous air from the basin and shall exhaust air through the carbon vessel. Fans shall be tested and rated in accordance with ASHRAE 51-75 and fan shall be licensed to bear the AMCA 210 Test Code Seal, and be certified by manufacturer to deliver rated performance. Manufacturer shall provide sound power level ratings outlined in AMCA Standard 301, ratings to be the results of testing in accordance with AMCA Standard 300. For additional details refer to Master Specifications Section 15880, Air Distribution Systems.

Service conditions shall include 1) Specified number of units, 2) CFM: as specified, balanced fan cfm shall not vary from quantity listed above by more than 5 %, OCSS shall co-ordinate fan total static pressure with actual total pressure drop across the carbon material bed, 3) the OCSS shall submit the calculations of static pressure requirements certified by a registered Professional Engineer in Michigan or any other state approved by Engineer, 4) total static pressure as specified, 4), fan rpm shall be as specified, 5) fan static efficiency shall be 64.4%, 6) outlet velocity shall be not be less than specified, 7) brake horsepower shall be as specified, 8) approximate noise level on weighted scale shall be less than 80 db maximum at 5 feet, 9) Sound power levels shall not exceed the following:

Octave bands	1	2	3	4	5	6	7	8	Overall
Total Fan Power Levels	112.3	109.3	103.3	65.3	89.2	87.3	90.3	83.3	114.5

Housing: Fan housing shall be designed so that there is no air leakage through joints and seals. All bolted pieces shall be tightened by putting gasket for air tightness. Fan housing shall be corrosion resistant, fire-retardant, sold fiberglass reinforced plastic design which shall equal or exceed the ASTM En 84 Tunnel Test Rating of 30 or less with construction classification suitable for pressure range. Fan housing shall be constructed of a premium brominated bisphenol-A vinylester resin. All exterior surfaces of the fan shall have a factory applied beige pigmented, paraffinated gel-coat with UV inhibitors. All laminates shall be manufactured in accordance with National Bureau of Standards PS 15-69, ASTM C 582. All interior portions of fan housing in the air stream shall be coated with graphite impregnated resin in accordance with ASTM D 4167.

Fan Wheel: Provide backward inclined fan wheel constructed of Type 316 stainless steel with back pressure vanes adjacent to shaft seal. Surface preparation of the metal surfaces to provide a surface metal profile via degreasing, radiusing and abrasive blasting. Remove all grit or dust particles.

Fan Shaft: Shaft shall be of Type 316 stainless steel designed to operate below first critical speed. Shaft and impeller shall be statically and dynamically balanced at normal operating speed listed in schedule below to allow a maximum vibration peak-to-peak displacement of 2 mils. Provide mechanical or Teflon seal between shaft and housing. The shaft's first critical speed shall be at least 125% of the fan's maximum operating speed.

Shaft Bearings: Heavy duty, grease, lubricated, sealed, self-aligning, pillow block design, frictionless ball bearings having minimum life of 150,000 hours shall be used. Fan bearings shall be visible and accessible for inspection and maintenance. Bearings enclosed within the fan housing where they can be exposed to the corrosive gas stream are not acceptable.

Fan impeller and driving pulley shall be secured to shaft with keys and set screws. Fan housing shall have flanged discharge and inlet drilled connection and companion flanges. Fan shall be separated from ductwork at inlet and outlet by flexible connections. Fan inlet box shall have flanged inlet and outlet connections. The fan inlet box shall be coated with graphite impregnated resin in accordance with ASTM D 4167. Equipment slab shall be unitary base constructed of channel steel as required by the fan manufacturer. The fan and motor shall both mount to the structural steel frame. Fan mounting shall be AMCA Standard Arrangement 1. Fan base shall be bolted directly to the equipment slab and painted as specified in Master Specification Section 09900, Painting. The drive shall be of matched V-belts and adjustable sheave pulleys shall be cast steel. The belt and shaft guard shall be steel construction and galvanized then painted as specified in Master Specification Section 09900, Painting, with tachometer hole, OSHA approved. The access doors shall be raised type, bolted with gasket. Nuts, bolts and fasteners in contact with the gas stream shall by Type 316-stainless steel and encapsulated in FRP. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, rated capacity in cfm, head in inches of water gage, fan rpm, and any other pertinent data shall be permanently affixed with stainless steel hardware to each fan.

Drains: Provide drains at low point of scroll, 1-inch pipe bonded to housing with threaded corrosion resistant plug.

Coatings: Ferrous metal fan part coatings shall as per Steel Structures Painting Council SSPC-SP 5-63 white metal blast cleaning. Ferrous metal fan part coating for baked epoxy phenolic or "cold set" epoxy-phenolic amine cured shall be brushed or sprayed coats as per manufacturer's specifications.

Fans: Fan assembly shall be tested and balanced in accordance with Master Specifications Section 15990, Testing, Adjusting and Balancing. The complete fan assembly shall be inter-radial dynamic machine (IRD) 245 balanced at design RPM with motor sheaves and belts in place to 1.0-mil displacement or less and shall be checked for vibration after installation by the fan manufacturer's personnel trained in such work. A complete report shall be furnished to Engineer. If the amplitude of any vibration exceeds 1.0 mils, the fan shall be dynamically balanced in place and retested.

Differential Pressure Gage/Switch: Provide a photohelic differential pressure gage/switch at the fan inlet and outlet, to measure the fan inlet pressure and the fan outlet pressure. Gage shall be the dial type with die cast aluminum, irridite dipped for corrosion resistance. The range for fan inlet shall be 10 in vacuum to 10 inches water gage and range for fan outlet shall be 0 to 12 inches water gage with accuracy of 2 percent of scale. Switches for high and low set point shall be adjustable from knobs on gage face.

Quantity	2 per unit
Type	DPDT, Rated 10 A @ 120 VAC
Power requirement	120 VAC
DeadBand	Maximum 1 percent of full scale
Enclosure	NEMA 4X

Manufacturer: Provide products of one of the following: Dwyer Instrument, Incorporated Model 3000 series Photohelic Pressure Switch/Gage, or approved equal.

2.3.03 Drive Units. Motors shall be provided with specified maximum horsepower at 1800 RPM constant speed. Motor information specified herein shall be coordinated with Master Specifications Section 16220, General Purpose Induction Motors. TEFC type with premium efficiency suitable for operation (480 volt, 3 phase, 60 Hz power, solid shaft, ball bearing type), mount Fan per manufacturer requirements for outdoor use, and shall be provided with a service factor of 1.15. Provide positive temperature thermistors and a solid state relay. The sealed thermistors shall be installed in the end turns of the stator winding, one per phase. Solid state relay shall detect and protect against open or shorted sensors. Relay shall be mounted in and powered from MCC (120 VAC). Relay shall provide dry contact interlock to shutdown motor on high temperature. Provide thermistors from one of the following manufacturers: Therma Sentry by U.S motors, Reliance Thermistor System by Reliance or approved equal. Provide 120 volt space heaters in motor windings to prevent condensation.

2.3.04 Controls. Odor Control Fan Operation: Furnish a local control panel for each fan, provided by the fan manufacturer, for mounting adjacent to each. Each odor control fan shall have two modes of operation, "Local" and "Remote". Fan shall be placed in "Local" or "Remote" from local control panel. In the "Local" position a fan shall operate by the "start" and "stop" pushbuttons located on the local control panel.

In “Remote” position, a remote signal from the specified control system in the control building shall start and stop the fan.

Safeties/Interlocks: All safeties/interlocks shall be hard wired to the fan MCC starter. All alarm conditions shall be repeated individually at the local panel and at the specified control system. In the “Remote” position, if a fan fails to start when called an alarm shall be signaled. If a fan fails when running, an alarm will be signaled. Low suction pressure shall stop a fan and signal an alarm. High discharge pressure shall stop a fan and signal an alarm. The “Stop” pushbutton shall stop a fan in both “Local” and “Remote” mode of operation.

Local control panel: Local control panel shall be a NEMA 4X enclosure mounted on support framework adjacent to the fan. Panel shall be all Type 316 stainless steel construction with a minimum thickness of 12 gauge for all surfaces (except those areas requiring reinforcement) having a smooth brushed finished. Provide continuous stainless steel piano hinged door with stainless steel screws and clamps on three sides of door. Provide all internal devices mounted on 12 gauge steel sub panel with white enamel finish.

2.4 GREASE FILTERS/MIST ELIMINATOR.

2.4.01 Acceptable Manufacturer. Provide grease filter/mist eliminators as manufactured by one of the following: Calgon Carbon Corporation, U.S. Filters, Munters Corporation, or approved equal.

2.4.02 Construction. Service conditions shall include that at the design gas flow rate, the external demisters shall remove minimum of 99.9% of droplets between 5 microns and 10 microns, and pressure drop through the demisters shall not exceed 1.0 in w.c. at 25,000 cfm.

External demisters shall contain horizontal grease and mist eliminator constructed of PVC with FRP frames. Provide two nested modules suitable for operation at the design gas flow rated 25,000 cfm.

The grease filter/mist eliminator shall be enclosed in FRP housing. The housing shall be of hand lay-up construction with the same resins and reinforcements as specified for the odor control vessel. Minimum thickness of the housing shall be 0.5 inches. The FRP shall be pigmented beige.
The grease filter pad shall be 2 inches thick and constructed of 304L stainless steel.

The mist eliminator pad shall be 4 inches thick and constructed of woven polypropylene. Provide a side mounted module access cover.

Gas inlet and outlet connections shall be circular, flanged connections the same size as the connecting ductwork. Flanges shall be of hand lay-up construction in accordance with NBS PS 15-69 and shall be ANSI 16.5, 150 lb.

Provide a flanged, ¾ inch diameter drain connections at the bottom of the FRP housing.

Differential Pressure Gage/Switch: Provide a magnehelic differential pressure gages at each grease filter /mist eliminator to measure the differential pressure through the grease filter/mist eliminator. Gages shall be the dial type with die cast aluminum, irradiate dipped for corrosion resistance. The range shall be 0 to 15 inches water gage for the grease filter/mist eliminator, accuracy of 2 percent of scale. The accessories used shall be Two 1/8 inch NPT plugs, two 1/8-inch NPT pipe thread to rubber tubing adapters and three flush mounting adapters with screws, 50 linear feet of tygon plastic tubing, two static pressure tips, two plastic vent valves, with integral compression fittings on tips and valves. Mount gages as grease filter/mist eliminator on brackets provided by Contractor. Provide products of one of the following manufacturers: Dwyer Instrument Incorporated Model 2015 Magnehelic Gage, or approved equal.

2.5 <u>FAN ACOUSTICAL ENCLOSURE</u>.

2.5.01 <u>Acceptable Manufacturers</u>. Provide a Fan Enclosure Unit as Manufactured by on of the following: Niess, Industrial Acoustics Company, or approved equal.

2.5.02 <u>Construction</u>. Provide a double wall, insulated, acoustical enclosure for each fan-motor unit suitable for outdoor installation. The enclosure shall be complete with frame walls, roof, observations, windows and air intake and discharge silencers. All panels and components shall be prefabricated and shall not be susceptible to damage form extended to airflow, pressure differentials, vibration, air, temperature, or humidity. The entire enclosure shall be designed by the manufacturer to be self-supporting when any or all of the side panels are removed. The enclosure shall be independent of the fan and ductwork. Enclosure size is shown approximately on the drawings. Final size shall be determined by the Contractor and enclosure manufacturer to suit the face actually furnished.

Enclosure shall have three double-leaf access doors on both long side and one double-leaf access door on the inlet side arranged to permit access to all parts of the fan assembly for services and major maintenance.
All panels shall be not less than 6 inches thick with a solid steel exterior shell with a minimum 16-gauge thickness and a perforated, galvanized steel interior shell with a minimum 22-gauge thickness.

The outer framework shall be constructed of steel with a minimum 11-gauge thickness, and shall be painted a gloss black color.

Each panel assembly shall be completely filled with acoustical/thermal insulating material that is noncombustible, inert, mildew resistant, and vermin-proof. Insulations shall not settle within the panel assembly. No insulating materials shall be used that have a flame spreader greater that 25 or smoke developed greater than 50, as determined by ASTM Standard E 84 (UL-723, NFPA 255).

Each panel shall contain a 1/8 inch thick layer of mineral wool attached to the perforated interior surfaces for vibration damping. The mineral wool layer shall be completely wrapped in 2 mil. Polyethylene for protection.

A layer of 1 inch thick mineral wool shall be placed adjacent to the vibration damping layer. Insert a 2 pound per square foot Septum barrier between the mineral wool and second 1 inch thick layer of mineral wool. The paint color shall be approved by Engineer.

Provide an additional 4 inch thick layer of mineral wool into the fabricated, galvanized steel frame. The exterior color of the panels shall be painted with industrial enamel paint.

Acoustical Performance: The manufacturer shall provide certified testing data from an acoustical laboratory, listing sound absorption and transmission loss characteristics of the panel assembly. Testing data may be for galvanized panels. The Insertion Loss measured at a 1 meter distance form the enclosure and 2 meter above the ground shall be a minimum of 24 dBA. The test shall be performed in accordance with the OSHA measurement standards and the NMTBA (National Machining Tool Builders Association) standards.

Insulating materials used in all prefabricated panel assemblies shall have the following maximum thermal conductivities and nominal thermal resistance (r) at a mean temperature of 75F.
Thermal Conductivity (BTU/HR ft^2-°F) Nominal R Value
4-inch panel construction -.06 BTU/HR ft^2-°F

All perimeter and interior channel members and trim items shall be of steel, not less that 11 gauge. Furnish all anchor bolts, nuts, and washers which shall be Type 316 stainless steel. The enclosure unit shall be bolted directly to the equipment slab.

Where required for acoustical performance, base/channel/floor interface shall be sealed with a caulking sealant. Sufficient sealant shall be used to extrude surplus sealant and give a visual indication of complete coverage in all joints. The sealants shall have sufficient adhesive strength to prevent air leakage through the assembly when a pressure differential exists, but still allow system disassembly without damage to the panel components.

Provide one 18 inch by 24 inch observation window to visually observe the motor. Window shall be constructed of double pane ¼ inch thick safety glass held in place with neoprene acoustical seals and separated by an air space of the same thickness as the panel.

Provide an acoustical air intake silencer and acoustical discharge silencers with an integral fan curb in the enclosure wall so it will admit air for cooling the enclosure with minimizing sound exiting enclosure. The air intake and discharge silencers shall meet the following service conditions and the requirements of Master Specifications Section 01180, Equipment, Materials, Parts, and Tools. Number of Units shall be as specified, CFM shall be as specified, and total Static Pressure in each silencer shall be in w.c.: as specified, for acoustical performance, the insertion loss shall be at a minimum equal the performance of the enclosure walls. The fan of the fan motor may provide primary air movement and cooling inside the enclosure. An auxiliary exhaust fan shall be mounted on the acoustical enclosure to provide air circulation during fan operation.

Auxiliary exhaust fan motors: Service conditions shall include number of units as 1 per enclosure, CFM shall be as specified, and Total Static Pressure each silencer, in w.c.:as specified. Motor information specified herein shall be coordinated with Master Specification Section 16220, General Purpose Induction Motors. The requirements of this article supersede any conflicting requirements in Master Specification Section 16220, General Purpose Induction Motors. The electric motor shall be Dome Type suitable for operation on 480 volt, 3 phase, 60 Hz power, solid shaft, and with ball bearing.

Openings for pipe penetrations and conduits shall be field cut to ensure proper positioning. Provide framing members, collars and fittings as required insuring the openings are sealed against acoustical leakage.

PART 3 – EXECUTION

3.1 INSPECTION. Inspect and verify that structures or surfaces on which the equipment will be installed have no defects, which will adversely effect installation, inspect all equipment prior to installation, and promptly report defects, which may affect Work to the Engineer.

3.2 INSTALLATION. Install equipment in accordance with the Drawings, approved Shop Drawings, the manufacturer's instructions and the supplemental requirements. Connect all piping and instruments as required. Support all piping independent of odor control vessel. Align, adjust, and lubricate equipment in accordance with the manufacturer's instructions, and leave in proper working condition. Provide minimum of one inch of non-shrink grout below all floor stands. Touch up minor scratches and scrapes in painted finishes as specified in Master Specification Section 09900, Painting.

3.2.01 Protection. Field and shop painting shall be provided in accordance with Master Specification Section, 09900, Painting. Paint FRP surfaces of ductwork and grease filter/mist eliminator FRP housing. Prepare FRP surfaces by hand sanding FRP surfaces to be coated with a medium grit sand paper prior to painting. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughed without removing excess material. Painting shall be provided in accordance with Master Specification Section 09900, Painting.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Test. After Contractor and Engineer have mutually agreed that the equipment installation is complete and ready for continuous operation, Contractor and a qualified field service representative of the manufacturer shall conduct a running test of the odor control system in the presence of Engineer to demonstrate that the mechanism and its controls will function correctly. Make adjustments required to place equipment in proper operating condition. During initial operation and in the presence of manufacturer's representative the Contractor shall set dampers to balance the airflow through the vessel.

3.3.02 Inspection. A manufacturer's factory trained representative shall check and approve the installation before operation. The representative shall operate and test system in the presence of Engineer and verify that the equipment conforms to requirements, and instruct plant personnel on care and maintenance. The representative shall revisit the job site as often as necessary until all deficiencies are corrected. Perform testing, checkout and start-up of the equipment under the technical direction of the manufacturer's factory-trained representative. Do not energize motor operators without authorization from manufacturer's representative. Conduct a leakage test on each odor control vessel by providing a suitable area on site, but not on the basin cover to perform a hydrostatic test on each vessel by:

Filling each vessel to a height of 12' of water.

Allowing to standing for 2 hours to verify no leakage.

Vessel shall be inspected for leakage by manufacturer's representative.

Provide a written report in accordance with Section 1.4

If leakage is determined manufacturer shall submit a corrective action plan for the repair or replacement of the vessel. No corrective action shall be taken without Owner's approval.

If the vessel fails a second hydrostatic test, it shall be replaced.

Contractor shall install the odor control vessel within 24 hours of passing the hydrostatic test.

3.4 TRAINING. Furnish services of a qualified factory trained operations and maintenance serviceman to instruct and train operators in the proper care, operation and maintenance of the equipment. Provide these services for the time period of a minimum of 30 days and in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

3.5 MAINTENANCE. Provide services of factory trained representative of the manufacturer to correct defective work during the one year correction period. Replacement parts of equipment installed during the one-year correction period shall be equal to or better than the original.

End of Section

SECTION 15891

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. Furnish, fabricate and install all ductwork, including fittings, accessories, dampers, duct liner, hangers, diffusers, registers, grilles and any incidental work or components required to provide complete air supply, return and exhaust ductwork systems as shown on the Drawings and as specified herein.

In general, ductwork shall consist of any passageway made of sheet metal or other material substantially air-tight, used for the conveying of air, gas or materials. Included are fittings, transitions, bracing, fasteners, sealers, supports and accessories such as access panels, access doors, turning vanes and manual air balancing dampers. All ductwork shall be of size and material as specified herein and as shown on the Drawings. All duct sizes indicated on the Drawings are clear, inside dimensions. Where ductwork is lined with fiberglass, duct sizes shown on the Drawings are clear, inside dimensions to the duct liner material.

Any change in duct sizes, offsets, transitions and fittings required to accommodate job conditions shall be submitted to the Engineer for approval.

All ductwork and equipment shown on the drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.2 RELATED REQUIREMENTS. Cutting and patching is included in Division 2 except for items specified herein. Concrete work is included in Division 3 except for required HVAC anchor bolts, sleeves and templates, which shall be furnished under this Section.

Structural steel and miscellaneous metal is included in Division 5 except for supplementary steel required for HVAC hangers, equipment supports, anchors and guides, which shall be furnished under this Section.

Flashing and counter flashing is included in Division 7 except for items specified herein.

Painting is included in Division 9 except for factory finished HVAC equipment, HVAC shop painting and HVAC identification labeling and as required in Paragraph 3.15 below.

Exterior louvers and louver blank-off panels are included in this Section.

Thermal Insulation is included in Section 15290. This Section specifies the insulation type and thickness for the systems specified herein.

Electric duct heaters are specified in Section 15550 and installed under this Section.

Control dampers and duct mounted instruments are specified in Section 15950 and installed under this Section.

For fiberglass ductwork refer to Section 15895.

1.3 SUBMITTALS. Submit, in accordance with Section 01300, the following Drawings and data. Detailed equipment and ductwork drawings at a minimum scale of 1/8-in =1-ft-0-in. Drawings shall locate ductwork accessories including manual, automatic and fire dampers. Ratings of fire dampers shall be shown. Drawings shall also show and dimension maintenance clear spaces for motors, drives, coils, filters and access doors or panels. Indicate ductwork pressure class used for fabrication.

Standard shop and field installation details for transitions, elbows, takeoffs, discharge nozzles, turning vanes, access panels and doors, volume control and splitter dampers, hangers and volume extractors. When SMACNA references are used, the specific methods for the project shall be clearly defined. Where SMACNA has more than one option, the option to be used shall be indicated.

Ductwork materials, joining methods, reinforcing and material gauges. Where options are allowed by SMACNA, the proposed option shall be clearly defined. Indicate proposed materials and methods for ductwork and equipment hangers.

For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

All submittals shall contain a statement that Sections 15500, and all other Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4 REFERENCE STANDARDS. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. The Engineer shall resolve conflicts between published requirements.

Titles and abbreviations of Federal, State and industry standards, technical societies, associations and institutes and other organizations which may be used are as follows:

American Conference of Governmental Industrial Hygienists (ACGIH)

Air Movement and Control Association (AMCA)

American National Standards Institute (ANSI)

Air-conditioning and Refrigeration Institute (ARI)

Air Diffusion Council (ADC)

ADC 1062-R4 - Certification, Rating and Testing Manual.

American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE)

ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

American Society of Mechanical Engineers (ASME)

American Society for Testing and Materials (ASTM)

ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

Factory Mutual (FM)

National Institute of Standards and Technology (NBS)

National Fire Protection Association (NFPA)

NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

NFPA 102 - Standard for Grandstand, Folding and Telescopic Seating, Tents and Membrane Structures.

NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

Occupational Safety and Health Administration (OSHA)

Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

Underwriters Laboratories (UL)

UL 181 - UL Standard for Safety Tests for Flame-Propagation of Fabrics and Films.

UL 555 - UL Standard for Safety Fire Dampers.

UL 723 - UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE. Inspection by the Engineer’s representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents. The Owner and Engineer reserve the right to check and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

1.6 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer. All materials shall be stored in a covered dry location off of the ground.

1.7 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts and shall meet the requirements of Sections 01750 and 01760. In addition to special items, the following spare parts shall be provided:

Furnish all special tools required for normal operation and proper servicing of the equipment.

Provide a minimum of 1 or 5 percent of the total units rounded to the next full unit whichever is greater for each size and rating of the following components.

Fire damper fusible links

Thermostats

Thermometers

Pressure gages

Control relays

Damper operators

Control transmitters

Control transformers

Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers.

1.8 DEFINITIONS. Particular terminology used under this Section is defined as follows: Traffic Level and Personnel Level - Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends vertically to 8-ft above floor, walkways, platforms and stairs, and horizontally 3-ft beyond the edge of walkways, platforms, and stairs.

Exposed Piping and Ductwork - Piping and ductwork visible from the floor level and includes all piping and ductwork in equipment rooms, boiler rooms, etc.

Concealed Piping and Ductwork - Piping and ductwork not visible from the floor level and includes piping and ductwork above hung ceilings and in shaftways.

Supply Air Ductwork - Ductwork carrying air from a fan or air handling unit to the space or spaces to which it will be introduced. This air may have been heated or cooled or in the case of ventilation system the air would be neither heated nor cooled. Supply air ductwork extends from the fan or air handling unit to the registers, grills or diffusers at the end of the ductwork.

Return Air Ductwork - Ductwork carrying air from the space it was supplied to back to a fan or air handling unit. Return air ductwork extends from the registers or grills at the end of the ductwork to the air handling unit or connection with an outdoor air intake duct.

Exhaust Air Ductwork - Ductwork carrying air from a space to a fan and then to be discharged to the outdoors. Exhaust air ductwork extends from the registers or grills at the end of the ductwork to the fan. From the fan the exhaust ductwork extends to the discharge point, exhaust air damper, or exhaust air plenum, whichever comes first.

Relief Air Ductwork - Ductwork carrying air from a space without a fan to be discharged to the outdoors. Relief air ductwork extends from the registers or grills at the end of the ductwork, the discharge point, relief air damper, or relief air plenum, whichever comes first.

Outdoor Air Ductwork - Ductwork carrying untreated air from the outside to a fan or air handling unit. Outdoor air ductwork starts at the intake point, outdoor air damper, or outdoor air plenum, whichever comes last. The outdoor air ductwork extends to the fan, air handling unit, or connection with a return air duct, whichever comes first.

Mixed Air Ductwork - Ductwork that can carry either return air or outdoor air or a combination of both. Mixed air ductwork starts at the connection of the return air and outdoor air ducts and extends to the fan or air handling unit.

Outdoor Air Plenum - A plenum that extends from the opening in the skin of the structure to the outdoor air duct. If the outdoor air damper is directly at the intake or there is no outdoor air damper, the plenum will extend to the first size reduction. If the outdoor air damper is not at the intake, the plenum will extend to the outdoor air damper.

Exhaust Air Plenum - A plenum that extends from the opening in the skin of the structure to the exhaust air duct. If the exhaust air damper is directly at the discharge or there is no exhaust air damper, the plenum will extend from the last size reduction. If the exhaust air damper is not at the discharge, the plenum will extend to the exhaust air damper.

Relief Air Plenum - A plenum that extends from the opening in the skin of the structure to the relief air duct. If the relief air damper is directly at the discharge or there is no relief air damper, the plenum will extend from the last size reduction. If the relief air damper is not at the discharge, the plenum will extend to the relief air damper.

Ventilated Spaces - Areas supplied with outdoor air on a continuous or intermittent basis. The outdoor air may be heated and/or cooled or untreated.

Heated Spaces - Areas where heat is supplied to maintain a minimum temperature during the heating season.

Unheated Spaces - Areas where heat is not applied and there is no minimum temperature during the heating season.

Conditioned Spaces - Areas that are provided with heating and mechanical cooling.

Non-Conditioned Spaces - Areas that are not provided with mechanical cooling.

Thermal Conductivity - The rate of heat flow through unit area of a homogeneous substance under the influence of unit temperature gradient in the direction perpendicular to the area. Units-BTU per (hour)(sq ft)(degrees F temperature difference)(per inch thickness).

Indoor Ductwork - Ductwork within a building that is not exposed to the weather.

Outdoor Ductwork - Ductwork that is not within a building and is exposed to the weather.

Hot Ductwork - Ductwork carrying air with a temperature above the surrounding space temperature.

Cold Ductwork - Ductwork carrying air with a temperature below the surrounding space temperature.

Hot/Cold Ductwork - Ductwork carrying air with a temperature that can be either above or below the surrounding space temperature.

Flues/Stacks/Breeching - Ductwork carrying products of combustion to atmosphere.

1.9 COORDINATION. The Drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.

The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.

The Contractor shall assume full responsibility for coordination of the HVAC systems, including; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION FOR DUCTWORK. Flexible connections for conventional air conditioning systems shall be glass fabric coated with polychloroprene. Fabric must comply with Underwriters Laboratories Standard UL214 and NFPA Bulletin 90A. Connections shall be Ventglas by Ventfabrics or equal.

Flexible connections for process exhaust systems shall be fiberglass fabric coated with Duponts teflon. Fabric must be resistant to Sodium Hypochlorate. Fabric must comply with Underwriters Laboratories Standard UL181 and NFPA Bulletin 102. Connections shall be Ventel by Vent Fabric or equal.

Furnish flexible connectors at each inlet and outlet of fan and in the duct runs where required for expansion, contraction and movement, and where called for on the Drawings. Flexible connections shall be integrally flange molded arch type units constructed of EPDM rubber 1/4-in thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service. The flexible connections shall be designed to minimize the transmission of vibration from the fans to the ductwork at the suction and discharge connections. Expansion or contractor flexible connections shall be designed to allow 1-in movement. Working length or “live” length shall be as designed by the manufacturer to allow up to 1-in of movement.

Ends shall be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints shall be molded and free of patches or splices. The flexible connections shall be suitable for outdoor service and temperature ranges from minus 10 up to 125 degrees F, and pressure to 5 psig. Specially fabricated split Type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanged with Type 316 stainless steel bolts are tightened. Acceptable Manufacturer: Holz Rubber Company, Mercer Rubber, Company, Proco Products Incorporated, or approved equal.

2.2 FLAME AND SMOKE RATINGS. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the Federal Standard 00136B, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA. These requirements apply to all circumstances whether the materials are field applied or applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project.

2.3 SOUND CONTROL. The selection of ductwork and accessories shall be such as not to create noise that will exceed the levels of permissible noise exposures for occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances. Acoustical Lining - Internal sound attenuation and insulation (for air conditioning ductwork) shall be 1-in thick bonded fiberglass mat coated with black pigmented fire resistive coating on the air stream side. Liner shall comply with NFPA 90A requirements. Flame spread and smoke development ratings shall be 25 and 50 respectively. Material shall be Owens Corning; Aeroflex or equal.

2.4 HANGERS, SUPPORTS AND ANCHORS. Furnish supports, hangers and other devices necessary to support firmly and substantially the equipment and ductwork described in this Section. Ductwork support systems shall include restrains as required by the applicable building codes to withstand seismic loading. All equipment, ductwork, and supports that are installed outdoors shall be designed and installed to meet wind loadings as required by the International Building Code, all other applicable codes, and the requirements specified herein. Design shall be provided by a professional engineer hired by the Contractor as specified in other sections of the specification. Signed and sealed calculations shall be submitted for record purposes.

Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as called for in the SMACNA standards, except as limited below.

Rectangular ductwork 48-in wide and larger shall be supported by adjustable threaded rod hangers.

Round ductwork 37-in and larger shall be supported by two adjustable threaded rods at each support.

All hangers shall be of same material as ductwork which they serve, e.g., galvanized, aluminum, black steel, etc, except for PVC ductwork which shall be Type 304 stainless steel.

All hanger hardware and fasteners shall be of the same material as the duct they serve or shall be of a material with equal or greater corrosion resistance. Where materials other than the duct material are used, they must be approved by the Engineer before installation.

Perforated band iron or wire for supporting ducts shall not be permitted.

Where C-clamp type hangers are used, furnish with a retainer strap.

Support flexible duct withType 304 stainless steel band hangers, 1-in wide minimum, attached so as not to crush the ductwork. The use of wire to hang flexible ductwork shall not be permitted.

The following methods of hanger attachment to the building structure are NOT allowed. The numbers and letters refer to hanger methods shown in Figure 4-1, 4-2 and 4-3 of the 1985 edition of the HVAC Duct Construction Standards Metal and Flexable as published by SMACNA.

"T"- wrap around strap on open web joist.

"W" - bent over band on open web joist.

"14" - friction clamps.

"17" - bent wire in metal deck.

Design of hangers shall include the effect of all loads applied to the duct as well as the load of the duct. These loads include, but are not limited to wind, snow and internal dirt or liquid buildup.

Hangers shall not be supported from roof decking or bulb tees. Where required, provide supplemental steel to span between the building structures.

2.5 DUCTWORK MATERIAL. Ductwork shall be constructed of the materials specified using the gauges or thicknesses, reinforcing and construction methods in accordance with SMACNA standards. Unless otherwise specified, all components of the duct systems shall be constructed of the same material as the ductwork. This is to include braces and turning vanes.

Galvanized steel ductwork shall be constructed of hot-dip galvanized sheet steel, per ASTM A653.

Stainless steel ductwork shall be constructed of Type 316 stainless steel. Aluminum ductwork.

2.6 DUCTWORK CONSTRUCTION DETERMINANTS. Low pressure ductwork shall be constructed of the following materials and to the SMACNA standards:

The following is to be used as a general guide for duct material select.

Galvanized Steel – shall be used for normal heating, cooling, and ventilation applications where the air handled in surrounding the duct is relatively dry, and there are no corrosives.

Stainless Steel – shall be used in areas that galvanized steel and aluminum are not suitable and as shown on the drawing.

Aluminum – shall be used in areas where shown on drawing.

Design of ductwork shall include all loads applied to the ductwork, in addition to the load of the duct. These loads include but are not limited to wind, snow and internal dirt or liquid build up.

2.7 DUCTWORK CONSTRUCTION. All ductwork shall be substantially built with joints and seams smooth on the inside and given a neat appearance on the outside. Inside surfaces and joints shall be smooth and free from pockets, burrs and projections. All joints shall be substantially airtight with laps made in the direction of air flow and no flanges projecting into the air stream.

2.7.01 Pressure Classes. Pressure classes for determination of sheet metal gauge and reinforcing shall be as defined by the latest issue of the SMACNA - Industrial Duct Construction Standards. For systems with fans with a shut off static pressure higher than 2-in w.g., design pressure shall be as listed in Paragraph 2.06 above. For systems with fans a shut off static pressure 2-in w.g. or less design pressure shall be equal to the maximum pressure indicated for the fans or air handling units on the Schedules and the pressure class shall be the same for the entire length, including branches, of the specific duct system.

2.7.02 Rectangular Ductwork (Sheet Metal). Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA - Construction Standard. Cross-breaking shall conform to SMACNA standard. Cross-breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure rigidity for each panel.

Alternate Construction - Factory fabricated joint systems may be offered as an alternate form of construction. The system offered shall meet all requirements of

SMACNA. Alternate joint systems shall be "Ductmate System" as manufactured by Ductmate Industries, Inc., installed in accordance with the manufacturer's recommendations. The system shall be sealed for zero leakage and angle attachment to the main duct section shall be by tack welding. The use of screws is not allowed.

2.7.03 Round Ductwork (Sheet Metal). Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA - Construction Standard.

Round ductwork longitudinal seams shall be either lock type or continuous welded construction. Slip joints shall be used on ductwork and fittings up to 36-in in diameter and Vanstone flanges shall be used on ducts over 36-in in diameter.

Fittings shall be fabricated with continuous welds. 90 degree elbows shall have a turning radius of 1.5 times the fitting diameter. 90 degree elbows shall be mitered construction with five segments. All fittings in the round duct system shall be of the male and female type. Mechanically fasten the conduits together using sheet metal screws not less than four per fitting 6-in on centers maximum and equally spaced around the circumference of fitting.

Round ductwork and fittings shall be manufactured by United Sheet Metal; SEMCO or equal.

2.7.04 Insulated Round Flexible Ducts. Round flexible ducts shall comply with specified SMACNA - Construction Standards and be constructed of corrugated ductile aluminum that can be bent and rebent by hand and is self-supporting. 1-in insulation shall be applied around the outside and be finished with a vinyl cover.

Thermal conductivity of the insulation shall not exceed 0.27 BTU/hr/sq ft/1 degree F at75 degree mean temperature. Duct shall be Class I, per UL 181.

Maximum length shall be 5-ft. The remainder shall be galvanized sheet metal. Duct run shall be as short and straight as possible to minimize static resistance.

Ducts shall be Bendway as manufactured by Flexaust Company or approved equal.

2.8 VOLUME AND SHUT OFF DAMPERS. Rectangular dampers shall be multiple blade type with channel frame, exterior linkage and position indicator and locking device. Blades shall not exceed 6-in in width.

Round or oval dampers and splitters shall be shop fabricated, single blade type with position indicators and locking device. For galvanized sheet metal systems, material shall be two gauges heavier than ductwork or 18 gauge, whichever is heavier.

Dampers shall be constructed of the same material as the ductwork.

Shut off dampers shall have replaceable neoprene seals. Leakage rates shall not exceed 7 cfm/sq ft at 4-in w.g. for rectangular dampers and 0.15 cfm/in of perimeter at 4-in w.g. for round or oval dampers.

Dampers shall be supplied with locking quadrants. Quadrants in galvanized steel and black steel ductwork shall be galvanized steel. All other duct systems shall have stainless steel locking quadrants. Locking quadrants shall have a positive method of holding the damper in its selected position such as a bolt through both the quadrant and the lever arm. Systems using springs or other devices that can vibrate loose are not acceptable.

All dampers shall be flanged connections unless otherwise noted.

All dampers shall be selected for a rating that equals or exceeds the specified system pressure and velocity. Manufacturer shall be Ruskin or equal.

Balancing and balancing/shut off dampers shall be opposed blade. Shut off dampers shall be parallel blade.

2.9 ACCESS DOORS. Access doors shall be minimum 24-in by 24-in in ducts 26-in and larger. Where the duct size is less than 26-in, the largest door that can be accommodated shall be used. Access doors shall be of the same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air-tight fit with ease of opening and closing. Doors shall be substantially butt hinged, with heavy sash locks and substantial door pulls. Door openings and door frames shall be reinforced with bar stock or angle. Where ductwork is installed with duct liner or exterior duct insulation, the access door shall be of the insulated type. Access doors shall be factory fabricated. Where ductwork is constructed of aluminum or stainless steel, access door and hardware shall be of similar material.

Hand hole access panels shall be 12-in by 12-in, constructed of the same material as the ductwork, with peripheral gaskets and sash locks. Provide hinges or chain for attachment to duct.

2.10 FASTENERS. Sheet metal screws, drive cleats, cinch bands and other fasteners shall be fabricated from materials with an equal or greater corrosion resistance than the ductwork in which they are installed. Where a material other than the duct material is used, it shall be approved by the Engineer before installation

2.11 RELIEF DAMPERS. Relief dampers shall be manually operated or automatic gravity-type used for exhaust of air. Dampers shall be constructed of the same material as the ductwork with flanged connection and blades set in parallel-bladed position and gang operated by exterior linkage. Dampers shall have a shop coat of primer or aluminum finish as specified. Relief dampers shall be of size, type and capacity as specified on the Drawings. Adjustable counter-balanced gravity dampers shall be provided where indicated on the Drawings. Manufacturer shall be Ruskin or equal.

2.12 LABELS. The service of each duct along with and arrow indicating direction of flow shall be provided on each duct system. Labels shall be located not more than 26 linear feet apart and shall also be provided at both sides of wall penetrations, at each damper, and each equipment connection.

Labels shall contain the service spelled out, the duct size, and the equipment number of the equipment served. Label locations shall have unobstructed view from normal viewing locations.

Numbers and letters shall be die-cut from 3.5 mil vinyl film and pre-spaced on carrier film. Adhesive and finish shall be protected with one piece removable liners. Colors shall be white letters on black backgrounds.

The system for preparation and application of letters shall be Type B a.s.i./2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Letters shall be 3-in high Optima Bold, upper case using Grid 2 spacing. Direction arrows are to match. The instructions of the manufacturer shall be followed in respect to storage, surface preparation and application of letters.

Each piece of equipment is to be provided with an identification label listing the unit number and the areas served. Labels shall be as specified above.

2.13 DIFFUSERS, REGISTERS AND GRILLES. All diffusers, registers and grilles shall be of the shape, sizes, capacity and type as shown on the Drawings. On all duct openings that do not have a specific diffuser, register, grill or mesh cover provide a wire mesh cover.

Finish - Unless otherwise specified, diffusers, registers and grilles shall have the following finish. All diffusers, registers and grilles located in ceilings shall have a baked white enamel finish except where the ceiling system has an exposed aluminum support grid. Where the ceiling has an exposed aluminum support grid the diffusers, registers and grilles shall have a baked aluminum enamel finish. All diffusers, registers and grilles not located in ceilings shall have baked aluminum enamel finish.

2.13.01 Supply Air Diffusers. General - Diffusers shall be a factory-assembled unit of welded steel construction consisting of a housing with built-in louvers, cones, vanes or other means of directing discharge of air in a particular pattern principally for overhead or ceiling air diffusion. All diffusers shall be equipped with a volume control device. Distribution of air may be adjustable if so specified.

2.13.02 Exposed Duct Mounted Diffusers. Diffusers shall be of the adjustable type for ease of horizontal and vertical adjustment of air pattern. Refer to Drawings for direction of air throw. Each diffuser shall be equipped with an equalizing grid, baffles as required and extended bottom plate flange designed specifically for air diffusion from diffusers mounted on exposed ductwork. Acceptable manufacturers shall be Titus, Krueger and Price.

2.13.03 Supply Air Grilles. In general, grilles shall be a factory-assembled unit consisting of a grille with double deflecting adjustable airfoil vanes to diffuse supply air in the various directional patterns as shown on the Drawings. Grilles shall be of aluminum frame and border with aluminum louver blades. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Front and rear louver blades shall be individually adjustable. Where wall mounted, front blades shall be vertical and rear blades shall be horizontal. Where ceiling mounted, front blades shall be parallel to long dimension. Grilles shall be Series 272F by Titus Manufacturing Corp.; Krueger and Price.

2.13.04 Supply Air Registers. Registers shall be a factory-assembled unit consisting of a grille with adjustable vanes to diffuse supply air in the various directional patterns as shown on the Drawings and a damper. Grilles shall be of aluminum frame and border with aluminum louver blades. All registers shall be furnished with a sponge rubber gasket to prevent streaking. Supply air registers shall have aluminum opposed-blade dampers. Front and rear louver blades shall be individually adjustable. Where wall mounted, front blades shall be vertical and rear blades shall be horizontal. Where ceiling mounted, front blades shall be parallel to the long dimension.

2.13.05 Exhaust Air Grilles / Registers. Acceptable manufacturer shall be Titus Manufacturing Corp.; Krueger and Price

2.13.06 Return Air Grilles / Registers. Louver-Faced Return Air Grilles. In general, grilles shall be a factory-fabricated unit of aluminum frame border and louver blades. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Acceptable manufacturer shall be by Titus Manufacturing Corp.; Krueger and Price.

2.13.07 Eggcrate Type Return Air Grilles. Return air grilles shall be of all aluminum construction consisting of 1/2-in thick cores with 1/2-in square grid size. The square grid pattern shall provide maximum free area with minimum "see through." Acceptable Manufacturers shall be: Titus Manufacturing Corp., Price, Krueger Manufacturing Co., Inc., or approved equal.

2.13.08 Wire Mesh Covers. Where wire mesh covers are called for on the Drawings, the wire mesh and support frame shall be the same material as the duct where the cover is installed. Unless otherwise noted the wire mesh shall be 0.5-in mesh. The wire mesh shall be contained in a metal frame. The mesh shall be firmly attached to the frame to prevent it being pulled out of the frame by casual contact. The frame shall be a minimum of 16 gauge sheet metal or the minimum gauge for a flange based on SMACNA, whichever is greater. The frame shall be on both sides of the mesh creating a sandwich with the mesh in the middle. Fastenings shall go through the frame on both sides of the cover.

2.14 ROOF CURBS. Roof curbs shall be furnished for all roof mounted HVAC equipment including fans and relief or intake vents. Roof curbs shall be pre-fabricated type, minimum 12-in height and sized to match the dimensions of the equipment base supported. Roof curbs for fans are specified under Section 15860. Curbs shall be straight sided type of all aluminum welded construction with nominal 2-in thick acoustical/thermal insulation in curb walls. A perforated metal liner shall be provided to protect the insulation. Curbs shall provide a flat top surface regardless of the roof slope. Curb interiors shall be provided with protective coatings when a coating is specified.

2.15 TURNING VANES. Turning vanes shall be shop fabricated and installed in all abrupt rectangular elbows. Single thickness or airfoil type double thickness blades shall be chosen based on SMACNA recommendations.

Vanes shall be fabricated from the same material as the ductwork and manufactured by Elgen; Duro-Dyne; Aero/Dyne or equal.

2.16 VOLUME EXTRACTORS. Volume extractors shall be shop fabricated with synchronized curved extractor blades, heavy side rails and screw operator.

Extractors shall be fabricated from the same material as the ductwork and manufactured by Carnes; Titus or equal.

2.17 FIRE DAMPERS. Fire dampers shall meet local codes and the requirements of the NFPA Pamphlet No. 90A. Dampers in systems constructed of materials other than galvanized steel shall be constructed of Type 316 stainless steel.

Dampers shall be sized so that the free air space is not less than the connected duct free area. Location shall be as shown on the Drawings and required by code. Dampers shall have a minimum 1-1/2 hour standard fire protection rating in accordance with NFPA Pamphlet No. 252 and UL 555. Where the fire protection rating of the partition exceeds 2 hours, multiple dampers in series may be used to provide a rating equal to the partition.

Fusible Links - Dampers shall be arranged to close automatically and remain tightly closed upon the operation of a UL approved fusible link or other approved heat actuated device, located where readily affected by an abnormal rise of temperature in the duct. Fusible links shall have a temperature rating of 50 degrees F above the maximum normal duct operating temperature, but not less than 165 degrees F.

Workmanship - Install dampers in sleeve unless noted otherwise on the Drawings or in the case of dampers listed for installation without sleeves after specific approval from the Engineer. Fire dampers shall be installed to provide a positive barrier to passage of air when in a closed position. Dampers shall be installed so they will be self-supporting in case of duct destruction due to heat. Care shall be exercised that the frame be set so that the closing device will not bind.

Factory fabricated, steel-curtain type, UL approved fire dampers, with damper blades out of the air stream, are acceptable. These fire dampers shall be installed in accordance with the manufacturer's instructions and UL 555.

Access Doors - Tight fitting access doors shall be provided for accessibility to dampers and fusible links for inspection and maintenance.

All fire dampers shall have written approval from local authorities.

PART 3 - EXECUTION

3.1 INSTALLATION OF DUCTWORK. Fabricate and erect all ductwork where shown on the Drawings, as specified herein, and in accordance with SMACNA standards. Rigidly support and secure ductwork.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

Wherever ducts are divided, maintain the cross-sectional area. All such changes must be approved and installed as directed by the Engineer or as approved on shop or erection drawings.

During installation, temporarily close the open ends of ducts to prevent debris and dirt from entering. Install work in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.

Install louver blank off panels provided by the louver manufacturer as specified under Section 10200. Provide louver manufacturer the louver blank off panel dimension requirements. Secure blank off panels to the building structure using aluminum angles and rustproof fasteners. Caulk perimeter completely to eliminate water penetration.

Cross-break sheet metal in accordance with SMACNA duct construction standard. Apply cross-breaking to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure each panel section being rigid.

Cross-break streamlined ducts on top only and adequately brace internally.

Beading as specified in SMACNA will be acceptable in lieu of cross-breaking.

The Drawings of the air ducts and air risers show the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes must be considered in the original bid and shall be installed at no additional cost to the Owner.

All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required. Wherever this is necessary, maintain the cross-sectional area. All of these changes, however, must be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.

The taper of all transformations shall be not more than 15 degrees.

Secure casing to curbs according to SMACNA "Duct Construction Standards."

Provide baffle plates as required to prevent stratification and to provide proper operation of controls.

Where ducts are constructed of materials other than galvanized steel the reinforcing members shall be of the same material as the ductwork.

The use of button punching or snap locks on ductwork constructed of aluminum shall not be permitted.

Ducts carrying moist air that pass through areas that could cause condensation shall be pitched to facilitate condensate removal. Low points of such ducts shall be provided with drains.

Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.

3.2 HANGERS. Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as recommended in the SMACNA standards except as noted in PART 2.

Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow adequate vertical adjustment. Do not use building siding or metal decking to hang ductwork.

Ducts shall not be supported from furring, hung ceilings or from another duct or pipe.

C-clamp type hangers shall be supplied with a retainer strap.

Ductwork shall not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.

Duct support at flexible connections shall be adjustable for ease of aligning the duct to the piece of equipment.

3.3 SEALING OF DUCTWORK. General - Unless otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section. All transverse seams, joints and fitting connections, both shop and field assembled, shall be sealed in accordance with this Section. Longitudinal seams shall be sealed on all duct systems with a design operating pressure greater than 2-in w.g.

Application of Sealant - Thoroughly clean all seams, joints, etc, of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before the sealant is applied.

Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.

Duct Tape - The use of duct tape alone for sealing ductwork is prohibited. Duct tape may be used primarily for the purpose of retaining the uncured duct sealant in seams and joints until it has cured. Duct tape shall not be applied to the inside of any duct nor shall it be applied to standing type joints at any time. All duct tape used shall be compatible with the sealant. The use of sealant saturated tape is acceptable when part of an integrated sealing system.

Sealant shall be either in liquid form or a mastic with a maximum flame spread of 25 and a maximum rate of fuel contributed and smoke developed of 50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.

Sealing systems shall be suitable for the environment. The following schedule is to be used to select the sealant.

Indoor, dry galvanized round and rectangular duct is to be sealed with Iron Grip 601 or equal.

Indoor, dry, stainless steel, aluminum and PVC coated is to be sealed with FTA 20 adhesive and DT-Tape gypsum or equal.

All other areas unless otherwise noted are to be sealed with FTA 50 adhesive and DT- Tape gypsum or equal.

All sealers listed are manufactured by Hardcast Inc and are to define the type of sealer. Other equal sealants are acceptable.

3.4 DUCTWORK FITTINGS AND ACCESSORY ITEMS. Duct Elbows - Changes in direction and offsets shall be made in a gradual manner to facilitate streamline flow of air. All elbows shall have a centerline radius of not less than 1-1/2 times the width of the duct in the plane of the elbow. For rectangular ductwork where full radius elbows cannot be installed, provide abrupt elbows equipped with shop-installed turning vanes unless noted otherwise on the Drawings.

3.4.01 Flexible Fabric Connectors. Install flexible connectors for vibration isolation at all duct connections to fans, fan units or blowers, air handling units and air conditioning units. Make connections substantially airtight at all seams and joints.

Where the construction of the flexible connection or vibration isolator results in a cross sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.

Provide flexible duct connections at both the intake and discharge connections for all fans and air handling units except as noted below.

Wall and roof fans that have integral motor/fan wheel isolation.

Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations, and the unit is mounted without vibration isolators between the unit and the support structure.

Ductwork spacing and alignment for flexible connections shall be aligned to the tolerances of the flexible connection manufacturer, or plus/minus 1/4-in whichever is less. Bolts shall be torqued to the manufacturer's recommendations. Do not over tighten.

Where flexible connections are used as expansion joints, the manufacturer's precompression recommendations must be followed. When the temperature at installation differs from the temperature in the precompression recommendation, a correction shall be made.

3.4.02 Dampers. Install manual volume control dampers wherever it may be necessary to regulate air volume for system air balancing and where shown on the Drawings.

Install splitter dampers, where shown on the Drawings, to regulate air volume for system air balancing.

Install motorized and pneumatic actuated dampers when supplied by other trades.

3.4.03 Volume Extractors. Factory-fabricated volume extractors shall be installed at all main duct takeoffs to supply air diffusers.

3.4.04 Access Doors. Hinged access doors shall be installed where listed below, wherever shown on the Drawings and wherever access may be required for service, maintenance and adjustment.

Provide access doors at the following locations (minimum requirements):

Coils in ducts - both entering and leaving side.
Motorized or pneumatic actuated dampers - linkage side.
Duct mounted temperature controllers.
Freeze-stats.
Smoke detectors.
Plenums.
Fire dampers.
Smoke dampers.
Electric duct heaters.
Filter banks.
Manual dampers and splitters.
Inlet side of centrifugal fans.
Volume extractors.
Inlet and outlet ducts to fans and air handlers.
As necessary or required.

Where access doors are required in ductwork located above ceilings, coordinate the location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.

3.4.05 Duct Liner. Duct liner shall be shop installed on the interior surfaces of ductwork, where shown on the Drawings or as specified herein. Installation shall be made using a single thickness of duct liner and shall be in accordance with Duct Liner Application Standard by SMACNA. Liner shall be adhered with adhesive having a minimum of 90 percent coverage. Fasteners shall be spaced in accordance with SMACNA. After the duct has been formed the leading edges of the insulation that will be abutting another lined duct shall be spray-coated with fire-resistive adhesive. For ductwork with velocities exceeding 4000 fpm a metal nosing shall be installed at all transverse edges to secure the duct liner.

3.4.06 Blast Gates. Blast Gates shall be installed where shown on the Drawings. After final balancing of the system, drill a hole through both the frame and gate and insert a positive locking device, such as a pop rivet, to prevent moving the gate.

3.5 GRILLES, REGISTERS AND DIFFUSERS. The location of diffusers, registers and grilles shall be as shown on the Reflected Ceiling Plans and as shown on the ductwork drawings. The exact location of these devices shall be determined in the field in cooperation with the other trades. Install all devices in an approved manner in accordance with the manufacturer's recommendation.

3.6 FLEXIBLE DUCTWORK. Make connections, joints and terminations air tight as recommended by the manufacturer. Where joints are made to rigid sheet metal ductwork, apply 3M Company EC-800 sealer and the joint shall be drawn tight with a drawband. Collars shall be 2-in long minimum and sleeves shall be 4-in long minimum. Install flexible ducts with one duct diameter-radius elbows and cut as short as possible. Duct shall not be compressed and the length shall be kept short so minimum hangers or supports are required and static pressure losses are kept to a minimum. Sag in flexible duct shall not exceed 1/2-in/ft between duct supports.

3.7 FILLING IN SPACE AROUND DUCTWORK. To prevent sound passing through the area between the duct and the framed or cut opening in the floors, walls or partitions, pack mineral wool to completely fill the space the full depth of the opening. Whenever a fire-rated wall or floor is penetrated and a fire damper is not required, fill the space around the duct with a locally approved fireproof rope. At penetration, apply escutcheon plates on both faces of the wall to close the gap between the structure and the sides of the insulated or bare duct. Escutcheon plates shall be the same material as the duct for metal ducts and stainless steel for PVC ducts.

3.8 DUCT SUPPORTS AT FLOOR PENETRATION. Where vertical ducts pass through floor openings and a fire damper is not required, rigidly attach supporting angles to the ducts and anchor with expansion bolts to the floor or curb. Angles shall be of the same material as the duct for metal duct and stainless steel for PVC ducts, placed on the two long sides of the duct extending 3-in over edge of opening and shall not be less than the sizes recommended by SMACNA.

Remaining open area in the floor opening shall be sealed with a plate of the same material as the angle.

3.9 SUPPORTING OUTDOOR DUCTS. Roof top ductwork shall be installed using structural steel angles for support. Sizes of angles shall be as shown on the Drawings.

The vertical supporting angles shall be continuous full height of the duct and shall be bolted to same. Intermediate duct supporting angles and bottom plates shall be welded to the vertical angles. Weld all of these angles together to form a stiff continuous supporting unit for the duct. Paint angles with rust inhibitive primer after welding.

Slope ductwork to shed water.

3.10 DUCTWORK TERMINATIONS AT MASONRY OR CONCRETE. Where ducts terminate at masonry or concrete openings, place a continuous 2-1/2-in by 2-1/2-in by 3/16-in angle of the same material as the duct around the ductwork. Use stainless steel angles for PVC ductwork. Bolt the angle to the construction and make airtight by applying caulking compound on the angle before it is drawn down tight to construction.

Fasten plenums to concrete curbs with 3-in by 3-in by 1/4-in continuous angle. Concrete curbs are provided under another Division. Mount angle on a continuous bead of caulking compound and anchor to the curb on 16-in centers. Terminate duct at the curb and bolt to the angle. Seal the duct to the curb with a continuous bead of caulking compound. Apply neoprene filler strip to level curb surface as necessary

3.11 DUCTWORK GENERATED NOISE. All ductwork shall be free from pulsation, chatter, vibration or objectionable noise. After system is in operation, should these defects appear, correct by removing, replacing or reinforcing the work. No discreet tones will be allowed.

3.12 PLENUMS. Seal fresh air inlet and exhaust air plenums watertight at louvers or otherwise subject to water entrainment at all bottom joints and seams and up all vertical seams for a minimum of 12-in. Remove excess sealant before it sets hard. Where possible, pitch fresh air inlet and exhaust air plenums down towards the louver. Where it is not possible to pitch the plenum, provide a 1-in capped drain connection at the low point of the plenum.

3.13 TEST PORTS. Where shown on the Drawings and where required for testing and balancing, provide instrument insertion ports. Size and location of ports shall be coordinated with the Contractor performing air balancing. Seal ports with plastic snap lock plugs. When the ductwork will be insulated, extend the port to the face of the insulation and seal the vapor barrier to the port. When the ductwork is lined, extend the port into the duct to the inner surface of the duct liner.

In round ductwork provide 2 ports 90 degrees on centers. In rectangular ductwork provide ports as required by AABC or NEBB for a full traverse measurement.

As a minimum, ports shall be provided in the following connections:

All duct mains.

All duct branches unless all connections are diffusers, registers, or grilles and the total can be calculated by summing the readings for all of the connections.

All connections to tanks or hoods where there is no other access for taking a measurement.

A main duct is defined as one of the following:

A duct serving five or more outlets.

A duct serving two or more branch ducts.

A duct emanating from a fan or plenum.

All remaining ducts are considered branch ducts.

3.14 ADJUSTMENT. Start-Up and Temporary Operation

Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner.

3.15 PAINTING. Paint the outside face of all louver blank off panels and the interiors of unlined plenums and ductwork where connected to louvers. Prime and paint with two coats of flat black exterior paint. Painting shall be performed under this Section and shall be as specified in Division 9.

3.16 CLEANING OF DUCTWORK. Maintain all ductwork, fans, coils, air filters, outlets and other parts of the ductwork systems in a clean condition during installation. Clean complete ductwork systems prior to testing and air balancing. Secure cheese cloth over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

3.17 I NSTALLATION OF DUCTWORK INSULATION. Provide ductwork insulation as specified under Section 15250 and with thickness as specified under this Section.

Ductwork Insulation - Blanket Type (Type I-5)

Hot Ductwork (Heating and Ventilation)

Insulation Thickness - Concealed round and rectangular hot ductwork.

Supply ducts in heated spaces - 1-1/2-in

Supply ducts in unheated spaces - 2-in

Return ducts - 1-1/2-in

Mixed air ducts - 1-1/2-in

Cold and Hot/Cold Ductwork

Insulation Thickness - Concealed round and rectangular cold and hot/cold ductwork and exposed round cold and hot/cold ductwork.

All ducts in non-conditioned spaces 2-in

All ducts in conditioned spaces 1-1/2-in

Outdoor air ducts and plenums 2-in

Exhaust air ducts and plenums between shut-off damper and outdoors 1-1/2-in

Ventilation supply air ducts and plenums between shut-off damper and outdoors 2-in

Ductwork Insulation - Fiberglass Board Type (Type I-6)

Hot Ductwork

Insulation Thickness - Exposed rectangular hot ductwork.

Supply ducts in heated spaces 1-1/2-in

Supply ducts in unheated spaces 2-in Return ducts 1-1/2-in

Mixed air ducts 1-1/2-in

Cold and Hot/Cold Ductwork

Insulation Thickness - Exposed rectangular cold and hot/cold ductwork.

All ducts in non-conditioned spaces 2-in

All ducts in conditioned spaces 1-1/2-in

Outdoor air ducts and plenums 2-in

Exhaust air ducts and plenums between shut-off damper and outdoors 1-1/2-in

Ventilation supply air ducts and plenums between shut-off damper and outdoors 2-in

Ductwork Insulation - Closed Cell Foam Type (Type I-7)

Insulation Thickness - Outdoor mounted round and rectangular hot, cold and hot/cold ductwork.

All air ducts 2-in

Weatherproof all outdoor ductwork.

All ductwork, except as specifically noted below, shall be insulated unless approved in writing by the Engineer.

Exposed supply and return air ductwork located in the area it serves.

Exposed ventilation exhaust and relief ductwork located in the area it serves.

Exposed ventilation and relief ductwork located in areas that are neither heated
nor cooled.

Exposed outdoor air intake ductwork and plenums located in areas that are neither heated nor cooled.

Return air ductwork located in return air ceiling spaces above the area it serves, except where the return ductwork is installed in ceiling spaces with a roof above.

End of Section

SECTION 15950

ELECTRIC AUTOMATIC TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE. Furnish and install a complete electric automatic temperature control system as manufactured by Honeywell, Inc., Johnson Controls, Andover Controls or approved equal. The automatic temperature control (ATC) shall be as specified herein and shall perform the functions specified and shown on the Drawings. The control system shall be installed by competent mechanics, technicians and electricians approved by the automatic temperature control manufacturer. The manufacturer shall be fully licensed at the time of bid to do business in the job site area for each type of subsystem. Wholesalers, contractors, franchisers, dealers, or any firm whose principle business is not that of manufacturing and installing DDC controls will not be acceptable. The manufacturer shall provide a system to meet requirements of NFPA-72A, 72B, 72C and 72D, and shall be listed by UL. Each component of the system shall be, where applicable, UL listed for the intended service. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.

The control system shall consist of all thermostats, temperature transmitters, flow switches, flow elements, transformers, alarms, flow transmitters, local flow controllers, ionization type smoke detectors, automatic valves and dampers, damper operators, control panels, electric relays, and other accessory equipment along with a complete system of wiring and conduit to fill the intent of the specification to provide for a complete and operable system. All control equipment shall be fully proportioning, except as noted otherwise.

HVAC equipment remote monitoring coordinate with Owner’s ovation facility management system contractor and fire alarm system contractor. Provide necessary equipment to achieve required control operation. Control sequences shall be as shown on the Drawings to be Automatic Temperature Control System. Coordinate with HVAC equipment manufacturers for controls furnished with the equipment.

1.2 RELATED REQUIREMENTS. The following shall be furnished and/or installed, under other sections:

Separable thermometer wells are included under Division 15.

All necessary valve pressure taps, water drain and overflow connections and piping are included under Division 15.

On magnetic starters the necessary auxiliary contacts, with buttons and switches in the required configurations are included under Division 15 and Division 16.

The necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified is included under Division 15. Locate baffles by experimentation and affix and seal permanently in place only after stratification problem has been eliminated.

Access doors or other approved means of access through ducts for service to control equipment is included under other Sections.

The installation of the following shall be under Division 15:

Automatic valves. Section 15950

Automatic dampers. Section 15950

The following are to be furnished and installed under other sections of Division 15, but will be integrated with the work of this Section:

Air Handling Units Section 15855.

Centrifugal Fans Section 15860

Heating Equipment Section 15550.

1.3 SUBMITTALS. Submit, in accordance with Section 01080, shop drawings and product data for the following:

Control drawings with composite wiring diagrams, and description of operation for all systems.

Panel layouts and nameplates lists for all local and central panels.

Valve and damper schedules showing size, configuration, sizing, pressure vs. flow diagrams for the fluid used, capacity, and location of all equipment.

Data sheets for all control system components.

Provide a recommended list of spare parts to be provided.

Sequence of operation descriptions.

Technical specification data sheets of each system component and device with indication of its use.

Complete listing of deviations from the system as specified.

Training manuals for each of the subjects required to be covered in training to include teaching plans, duration of each class, and maximum size of each class are to be submitted for review a minimum of three months prior to starting training. The manuals are to be broken down into the material required for each of the various courses. The submittal shall also include supplemental materials that will be used in the class and copies of overheads or slides if they are not in the preceding material.

All submittals shall contain a statement that Section 15501, and all other Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4 QUALITY ASSURANCE. The manufacturer must have a branch office facility with 50 miles of the project for at least 5 years, with technical staff and complete spare parts inventory and test and diagnostic equipment to keep systems in operation 24 hours per day 7 days per week. He/She shall have emergency service available in the local area for temperature control systems for which he/she is currently performing on-call emergency service 24 hours per day 7 days per week with a maximum response time of 4 hours. The automatic temperature control contractor shall have in his/her direct employ the personnel capable of detailed engineering, coordination, drafting, procurement, and expediting, scheduling construction, testing, inspection, installation, startup, calibration, and commissioning. The equipment to be furnished under this Section shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Several manufacturers are indicated as acceptable for some items of equipment in these specifications. The contractor shall be responsible for determining that all equipment supplied for this project is suitable for installation and proper operation in the space provided with fully adequate operating and maintenance access space.

The equipment furnished for installation under this Section shall be tested at the factory as standard with the manufacturer of the equipment. Unless otherwise indicated, the controls shall maintain space temperatures within plus or minus 0.5 degrees F, and space relative humidity within plus or minus 5 percent of their set points. Inspection by the Engineer’s representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements. All work to applicable codes and Owner’s standard practice.

1.5 COORDINATION. All coordination responsibility is vested on the General Contractor.

1.6 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved Shop Drawings upon delivery. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer. All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container. Instructions for servicing and startup of equipment in long term or prolonged storage shall accompany each item. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.7 ENVIRONMENT. All components, including data processing equipment, shall be suitable for operating in a normal plant environment without requirements for special temperature and humidity control.

1.8 WARRANTY. Provide one gear part and labor warranty after the completion of the project. Meet the requirements of Section 01170.

1.9 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts. In addition to special items, the following spare parts shall be provided:
Furnish all special tools required for normal operation and proper servicing of the equipment.

Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:

One complete set of gaskets for each sealed unit.

Provide a minimum of 1 or 5 percent of the total units rounded to the next full unit whichever is greater for each size and rating of the following components:

Thermostats

Humidistat

Thermometers

Pressure gages

Control relays

Damper operators

Valve operators

Control transmitters

Control transformers

Photo-electric type smoke detectors

Ionization type smoke detectors

Provide a minimum of 4 or 10% of the total units rounded to the next full unit whichever is greater for each size and rating of the following components:

Panel light bulbs

Fuses

Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers. Spare parts shall meet the requirements of Sections 01180.

PART 2 - PRODUCTS

2.1 MATERIALS. All products and materials used in this project shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved in writing. Spare parts shall be guaranteed to be available for a minimum of five years after the completion of the project.

2.2 ATC EQUIPMENT.

2.2.01 Area Classification. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification. Special attention shall be given to hazardous areas specifically "Class I, Group D, Div. 1" and "Class I, Group D, Div. 2" to comply with code requirements for equipment selection and installation procedures. The type of enclosure shall be as specified in Division 16.

2.2.02 Room Thermostats. Temperature sensors shall be provided with concealed adjustment, exposed thermometer for displaying room temperature. All temperature sensors shall have an end to end (element to readout display) accuracy of plus or minus 0.5 degree F. Temperature sensors shall be of the wire-wound resistive element type (RTD) using either nickel or platinum alloy as the resistive element. All temperature sensors shall have an end to end (element to readout display) accuracy of plus or minus 0.5 degree F. Thermostats shall be of the heavy duty all metal type 24 volt, provided with concealed adjustment and exposed thermometer. Provide rugged clear plastic-locking cover and steps of control as required. Room thermostat and temperature sensors mounted on exterior walls shall be provided with insulated mounting plates. All room thermostats and sensors shall be mounted 4-ft-0-in above finish floor except where otherwise indicated on the Drawings or specified herein or as required by code. Electric thermostats in corrosive areas shall be installed in electric boxes with remote stainless steel bulbs.

2.2.03 Low Temperature Duct Mounted Safety Thermostat. Electric low temperature thermostats shall be duct mounted probe type. These thermostats shall be two- position with manual reset.

2.2.04 High Temperature Safety Thermostat. Electric high temperature thermostats shall have a bimetal type sensing element with at least a 10-in insertion length. These thermostats shall be two-position manual reset type.

2.2.05 Static Pressure Sensors. Shall be adjustable, set point proportional type, with adjustable range in inches of water to meet the performance or function specified.

2.2.06 Ionization Type Smoke Detectors (Four Wire Type). Furnish and install ionization type smoke duct detectors downstream of the air filters and ahead of any branch connections in air supply systems wastewater process areas as shown on the Drawings and having a capacity greater than 2,000 cfm. In addition, furnish and install ionization type smoke detectors all exhaust systems serving wastewater process areas as shown on the Drawings and having a capacity greater than 2,000 cfm. Smoke detectors shall also be installed where shown on the Drawings and where called for on the control sequences.

Duct smoke detector shall be suitable for expected air velocity range, temperature range, humidity range, and contaminant range in the airstream as indicated on the associated HVAC Equipment Unit Schedules. The detector housing shall be listed per UL 268A specifically for use in air handling systems. The detector housing shall be equipped with an integral mounting base capable of accommodating either photo electronic or ionization detector heads. It shall be capable of local testing via remote testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL 268A, Standard for Smoke Detectors for Duct Applications. The housing shall be capable of mounting to either rectangular or round ducts without brackets. An integral filter system shall be included to reduce dust and residue effects on detector and housing, thereby reducing maintenance and service. Detectors shall be provided with two sets of DPDT 10 amp dry contacts in the smoke detector housing to provide smoke alarm signals. One contact is to be used by the ATC systems, and the second is for use by Division 16 for interface to the fire alarm systems.

Remote test switch and alarm indicator stations shall be furnished for all duct smoke detectors as specified above. The installation and wiring of the remote stations will be provided under this Section. The remote test stations shall be wall mounted within the visible location of the smoke detector and easily accessible from the floor.

2.2.07 Motorized Control Dampers. Source Quality Control: Motorized dampers for air intake shall allow a maximum air leakage of 5 cfm per square foot at 4 inches water gage static pressure. Design for maximum 6 inches water gage static pressure differential and 4,000 feet per minute approach velocity.

Type: Parallel Blade similar to Ruskin CD36.

Reference: SMACNA Standards.

Construction:

Tight seal ultra-low leakage construction.

Galvanized steel

Blades

Blade Shafts: 1/2-inch plated steel

All stainless steel construction where shown

Provide thermal blade edge seals for air tight damper closure.

Blade ends shall be sealed with spring loaded continuous strips fastened to frame.

Bearings: Bearings at each end of shaft.

Blades to be designed for minimal resistance to air flow.

Linkage brackets, connecting rods an mounting hardware. Provide bird screen where required.

Approved Manufacturer shall be:

Ruskin

Louvers and Dampers

American Warming

Arrow

or equal

2.2.08 Electronic Damper Actuators. Electronic actuators, less than 600 in-lb of rated torque, shall have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification. Electronic actuators used on valves shall be designed to directly couple and mount to a stem, shaft or ISO style- mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable. Actuators shall be two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.

Two sets of DPDT switches with fully adjustable set points shall be provided to activate panel indicators and provide signals for equipment operation. Actuator shall have an operating range of minus 22 to 122 degrees F. Proportional actuators shall accept a 0 to 10 VDC or 0-20 mA input signal and provide a 2 to 10 VDC or 4-20 mA (with a load resistor) operating range. Actuators shall be capable of operating on 24, VAC and Class 2 wiring as directed by the application. Power consumption shall not exceed 10 VA for AC, including 120 VAC actuators and 8 watts per actuator for applications. Provide transformer as required. NEMA 2 rated actuators shall be provided with a three foot (minimum), prewired, electrical cable. Actuators requiring removal of the actuator cover for access to wiring terminals, exposing electronics, printed circuit boards to damage, are unacceptable. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.

For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models >60 in-lb will be capable of mounting on shafts up to 1.05-in diameter. Spring return actuators with more than 60 in-lb of torque shall have a manual override metal crank. Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.

Actuators using “on-board” chemical storage systems, capacitors or other “on-board” non-mechanical forms of fail-safe operation are unacceptable.

Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators. Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be “off the shelf” standard actuators ready for field wiring. Damper actuators will not produce more than 62 dbA when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dbA with power on or in the running or driving mode. Where special classifications are shown on the electrical drawings damper actuators shall be provided with suitable enclosures. NEMA 4X enclosures shall be as specified in Division 16 and shall have a shaft seal and all electrical connections shall be suitable for the space classification. Enclosure shall be UL listed.

Explosion-proof enclosure shall be suitable for Class I, II and III as specified in Division 16. A suitable shaft seal must be provided. Housing shall be cast copper fill aluminum with stainless steel fasteners and shall be UL listed. Housing shall be suitable for NEMA 4, 7 and 9.

Local Direct Digital Control (DDC) Panels - General: Local DDC panels shall be standalone microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each local DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the control functions. Local panel shall be capable of communicating with Owner’s Ovation Facility Management system

Hardware Override Switches: As indicated in the control sequences, the operator shall have the ability to manually override automatic or centrally executed commands and reset alarms at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Indicator lights called for on the control sequence shall be on the face of the panel. Also provide audible alarm where shown.

Integrated On-line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.

Power Failure Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

All panels shall be provided with lugs, brackets or field supplied devices to allow the panel to be firmly fastened to the structure. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic loads for the area and type of application.

Miscellaneous Devices - Provide all the necessary relays, limit switches, positioners, valves, clocks, transformers, etc, to make a complete and operable system. Locate these devices on local ATC panel unless specified otherwise.

Set points on thermostats, temperature controllers, humidistats, humidity controllers and static pressure controllers shown on the Drawings are indicative only and devices shall be adjustable above and below such set points. If a set point is not stated, the control range of devices shall be suitable for the intended service. Range of devices shall be approximately 50 percent greater in both directions than span of variable, with a minimum of 25 degrees and a maximum of 100 degrees F for air systems. Thermometers - Thermometers shall be flush mounted on local panels. These thermometers shall be of the dial type, minimum 3-in diameter.

Flow Switches and Sensors - Duct air flow elements for modulating control shall be of the multipoint, self-averaging pitot tube, differential pressure type. Each element shall have air straightening vanes. These elements shall be fabricated of heavy-gauge, galvanized steel welded casing with 90 degree connecting flanges in a configuration and size equal to that of the duct it is mounted into. The maximum allowable unrecovered pressure loss through the element shall not exceed 0.065-in w.c. at 1000 fpm. Element accuracy shall be plus or minus 1 percent of actual flow rate over the flow range. Repeatability shall be plus or minus 0.1 percent of the actual flow rate over the flow range. Rangeability shall be guaranteed to meet flows as specified. Flow switches for clean air applications to include supply and makeup air systems shall be adjustable differential pressure type with an adjustment range suitable for the application including pressure range, temperature range, and expected containment range. Switches shall be arranged for sensing system velocity pressure through the use of a pitot tube arrangement. Pitot tubes shall be accessible and removable for inspection and maintenance without disturbing wiring connections or transmitters. Tube shall be stainless steel. Flow switches for general HVAC exhaust applications shall be vane (paddle) type switches suitably selected for the expected duct velocity, pressure range, temperature range, humidity range, and expected contaminants in the air stream. Positioned in the ductwork to be accessible and located so as to avoid nuisance tripping and unreliable operation due to flow turbulence. Vane and vane blocks shall be Type 316 stainless steel.

Switches and control wiring shall be arranged so switch is easily removable from ductwork to permit vane inspection, without disconnecting the wiring.

Thermal dispersion flow sensors shall be set and calibrated after air balancing has been completed. Unless otherwise noted, the set points for high or low shall be plus/minus 10 percent. For high high, or low low shall be plus/minus 15 percent. When the sensor has a varying speed response for start up and shut down, the shorter time response shall be used for the system alarm or shut down signal.

Where specifically called for on the Drawings or in the control sequences, current measuring devices shall be used for flow monitoring. Devices shall measure the actual current for the fan motor and compare it to a predetermined range. The range is to be determined by measurement during system balancing. The use of sensors that only respond to a condition of current or no current are not acceptable.

Electronic Sensors - All mixed air and coil discharge sensors shall utilize industry standard 4-20 mA sensors with averaging elements. Sensing elements shall be a minimum of 25-ft and temperature sensed shall be averaged over the entire length of the element. Thermistor type sensors will not be acceptable for this application. Space type sensors shall have an accuracy of plus/minus .5 degrees over sensed temperature range (20 to 120 degrees F).

Well type sensors used for liquid immersion shall have stainless steel removable wells. Sensing element shall have an accuracy of plus/minus .5 degrees over range (70 to 220 degrees F or 20 to 120 degrees F) of the sensor. Each sensor shall have a suitable electrical box to enclose all wiring connections.

Temperature control wells shall be installed according to manufacturer's recommendations.

2.3 ELECTRIC WIRING. All field wiring (other than power wiring) between control cabinets, control devices, unitary control panel and control terminals in motor control centers shall be furnished under this Section and shall conform to the requirements of Division 16. Wiring to suspended and cabinet unit heaters and their thermostats shall be considered power wiring. All interlocking wiring within MCC shall be done by Division 16. Refer to the electrical drawings for NEMA enclosure types.

Installation of all conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, system devices, etc, shall be in accordance with the appropriate requirements of Division 16, and in accordance with sections of the current edition of the local codes for signal systems and electrical systems.

Wiring shall be run in rigid steel conduit except in dry locations above ceilings and wood or metal stud framed partition walls, where EMT may be used. Conduit, boxes and fittings and their installation and testing shall be as specified in Section 16110.

In the event of any conflict among referenced codes, current editions of the applicable local codes shall take precedence for interpretation of "Signal System" installation requirements.

Installation of sensor wiring in finished areas shall be concealed whenever possible. Where concealed wiring is not possible, written approval for exposed work must be obtained from the Engineer prior to installation.

A power supply 115V, single phase, 60 Hz, 20 Amp circuit for ATC, requirements will be taken from local control panel. Power shall not be taken from the control power transformers of the motor control center. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.) All wiring in mechanical, electrical or service rooms or where subject to mechanical damage shall be installed in conduit at levels below 10- ft. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

All wire to device connections shall be made at a screw type terminal block or screw type terminal strip. All wire to wire connections shall be at a screw type terminal block. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals. All wiring shall be installed as continuous lengths, with no splices permitted between termination points. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations. Size of conduit and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and code requirements, except as noted elsewhere. Include one pull string in each conduit (1-in) or larger. Use coded conductors throughout with conductors of different colors.

Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment and control panel enclosures unless they also contain Class 1 starters.

Conceal all conduits, except within mechanical, electrical or service rooms. Install conduits to maintain a clearance of 6-in from high temperature equipment. Secure conduits with conduit clamps fastened to the structure and spaced accordingly to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork. Comply with Division 16 requirements where conduit crosses building expansion joints. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of all vertical conduits. The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site. Flexible metal conduits and liquid tight, flexible metal conduits shall not exceed 3-ft in length and shall be supported at each end. Flexible metal conduits less than 1/2-in electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid tight, flexible metal conduits shall be used. Conduits must be rigidly installed, adequately supported, properly reamed at both ends and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes.

PART 3 - EXECUTION

3.1 INSTALLATION. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

3.2 INSTRUCTION AND ADJUSTMENT. Upon completion of the project: Completely adjust and calibrate, ready for use, all thermostats, valves, damper operators, relays, thermometers and recorders, etc, provided under this Section.

Furnish four instruction manuals covering the function and operation of the control and automation systems on the project for the use of the Owner's operating personnel. A competent technician shall be provided for a period of 16 hours for instruction purposes.

The system contractor shall provide complete system documentation at acceptance time, as specified herein. Documentation shall be provided in four sets, unless otherwise elsewhere in this Section. Documentation shall include the following:

> All data specified in the Paragraph 1.03 above, in its final as-built approved form.

As-built interconnection wiring diagrams, or wire lists, or list of the complete field installed system with complete, properly identified, ordering number of each system component and device.

3.3 CONTROL SEQUENCES. HVAC equipment will operate with the sequences of operation shown on the drawings. The following will apply to all sequences.

> All sequences are reversible unless otherwise noted.
>
> Manual reset of control functions with manual reset will be at the local control panel unless otherwise noted.
>
> Where required to prevent nuisance shut downs of systems, provide time delay of sensors to allow system start up before the sensors are activated. This would include, but not be limited to low temperature freeze protection on 100 percent outdoor air units.
>
> The ATC contractor shall provide all connections, relays and other devices required to operate the system under the control of the firefighter control panel.

End of Section

SECTION 15955

BUILDING SYSTEM CONTROLS

PART 1 - GENERAL

1.1 SCOPE. This section covers the design, furnishing, and installation of control systems and instrumentation associated with the heating, ventilation, and air conditioning (HVAC) equipment and systems including all associated equipment, devices, and controls necessary for proper operation.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. The control and instrumentation shall be designed and coordinated for proper operation with the controlled equipment and materials furnished under other sections, under other contracts, and with related existing equipment. All controls devices and instruments shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the device manufacturer and controlled equipment manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment or instrumentation are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Review of drawings submitted prior to the final determination of related equipment shall not relieve Contractor from supplying systems in full compliance with the specific requirements of the controlled equipment. Controlled equipment and materials may include, but will not be limited to, fans, pumps, actuators, measuring devices, supervisory control equipment, cable, conduit, and piping as described in other sections. Installation drawings shall be prepared for interconnecting wiring and instrument tubing between the controlled equipment and equipment furnished in this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system. Contractor shall provide coordination with the other contractors and supervision of installation as needed during construction.

Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. The temperature controls supplier shall design and furnish a complete and functional control system in accordance with the drawings, specifications, and sequence of operation. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper and valve actuators, temperature/digital control panels, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the control circuits paragraph. Cable and conduit for all HVAC power circuits shall be as specified in Master Specification Section 16050, Electrical General Requirements.

Motor starters will be provided with terminal blocks for the termination of conductors for operational control and run/off status of the equipment. Refer to the electrical schematics for additional information.

The temperature controls supplier shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on suppliers representatives for temperature controls shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

When indicated by the applicable codes, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing organization acceptable to the governing authority.

1.2.04 Power Supply. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or necessary for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Control Equipment Items	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plateNameplates and tags shall be at least 12 gage thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm).

Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners. Nameplates shall be firmly secured to temperature control panels with stainless steel panhead screws.

1.3.02 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the drawings.

Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring and instrument piping with all terminals and ports accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

Control valve schedule with each valve identified by the designations used herein and on the drawings and cross-referenced to the manufacturer's equipment data sheet or bulletin. The schedule shall also list complete sizing data for each valve, giving design flow and temperature or pressure, actual pressure drop, normal position, fluid, actual close-off rating, actual capacity index, and any other pertinent data.

Sequence of operation for each system corresponding to the control schematics.

Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

Space thermostat schedule indicating the types of covers and means of adjustment for each space.

Conduit and wire types.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals with Master Specification Section 01160, Training and Operation & Maintenance Manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manual. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE. The equipment furnished for installation under this section shall be tested according to the manufacturer's standard procedures.

1.5.01 Contractor's Qualification. The entire system shall be designed, coordinated, and supplied by a qualified Contractor who is regularly engaged in the business of designing and building instrument and control systems for heating, ventilating, and air conditioning equipment. The Contractor shall have at least 5 years of documented experience in designing and installation of the products specified and shall be employed by the control manufacturer or be an approved certified installer with full responsibility for proper operation of the control including startup and calibration of each component in the controls system.

1.5.02 Manufacturer Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5.03 Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ± 2°F (1.1°C), and the relative humidity within ± 5 percent of the setpoint.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools .

1.7 EXTRA MATERIALS. Extra materials shall be packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Thermostats: 1 of each type.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. A complete system of automatic temperature controls shall be furnished and installed to accomplish the control described in the sequence of operations. All control equipment shall be compatible for operating with the control system provided.

The control system shall consist of all necessary thermostats, control valves, switches, relays, timers, and gauges in accordance with the sequence of operation indicated on the drawings. Technical engineering services, including but not limited to engineering, programming, installation supervision, commissioning, and troubleshooting shall be provided for a complete and functional system.

2.3 ACCEPTABLE MANUFACTURERS. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; Andover Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2.4 MATERIALS.

2.4.01 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.02 Electric/Electronic Control Systems. Electric/electronic control systems shall be furnished and installed as indicated on the drawings and specified herein.

2.4.03 Thermostats.

Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", Siemens Building Technologies, or approved equal.

Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 3.5°F (2°C). The thermostats shall have a spdt switch rated for 1 horsepower (0.746 W).

Two Position Corrosion Resistant Wall Mounted Thermostats. Two position wall mounted thermostats located in wet or corrosive environments shall be Honeywell "T631F", or approved equal.

Two position corrosion resistant wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 3.5°F (2°C). The thermostats shall have a spdt switch rated for 1 horsepower (0.746 kW).

Two Stage Wall Mounted Thermostats. Two stage wall mounted thermostats shall be Honeywell "T631B Airswitch", Penn Controls "A28AA-4", Siemens Building Technologies, or approved equal.

Two stage wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 2°F (1.1°C) for each stage and 3.5°F (1.9°C) between stages.

Low Limit Thermostats. Low limit thermostats shall be Honeywell "L480", or Penn Controls "Model A11A-1", Siemens Building Technologies, or approved equal.

Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet (6 m) long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35°F to 45°F (2°C to 7°C), and shall be manually reset.

Remote Bulb Thermostats. Remote bulb thermostats shall be Honeywell "T675A", Penn Controls "A19ABC-24", Siemens Building Technologies, or approved equal.

Remote bulb thermostats shall be line voltage, fast response type. The thermostats shall have a range of approximately 0°F to 100°F (-18°C to 38°C) with an adjustable differential of 3°F to 10°F (1.7°C to 5.6°C). The thermostat shall include a capillary holding frame suitable for duct mounting.

Modulating Wall Mounted Thermostats. Modulating, wall mounted thermostats shall be Honeywell "Model T92", Penn Controls "Model T80ABA-1", Siemens Building Technologies, or approved equal.

Modulating, wall mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have an operating range of approximately 63°F to 87°F (17°C to 31°C) with a throttling range of approximately 1.5°F to 6.5°F (0.8°C to 3.6°C).

Modulating Duct Mounted Thermostats. Modulating, duct mounted thermostats shall be Honeywell "Model T991", Penn Controls "Model A80ABA-2", Siemens Building Technologies, or approved equal.

Modulating, duct mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have a range of approximately 10°F to 90°F (-12°C to 32°C) with an adjustable throttling range of approximately 5° F to 24°F (3°C to 13°C), and shall be furnished with a duct mounting kit.

Explosionproof Thermostats. Explosion-proof wall-mounted thermostats controlling explosionproof equipment in Class I, Division 2, Group D areas shall be Honeywell "Model T6051B", Johnson Controls "Model A19BUC-2", Siemens Building Technologies, or approved equal.

Explosionproof wall-mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 45°F to 85°F (7°C to 29°C) with a nonadjustable differential of 1°F (0.6°C). The thermostats shall have a spdt switch rated for 10 amperes at 120 volts ac.

Duct-mounted thermostats controlling explosionproof equipment in Class I, Division 2, Group D areas shall be Indeeco "Model T94A-70", or approved equal.

Non-programmable Wall Mounted Thermostats. Non-programmable, wall mounted thermostats shall be Honeywell "Model T874", Penn Controls, Siemens Building Technologies, or approved equal.

Non-programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, electromechanical type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 42°F to 88°F (6°C to 31°C) with the following features:

- Automatic heat/cool changeover
- Auxiliary heat LED
- Tamper-resistant cover with thermometer.

Where an economizer is used, the non-programmable thermostat shall be suitable for interfacing with the economizer control package.

Programmable Wall Mounted Thermostats. Programmable, wall mounted thermostats shall be Honeywell "Model T7300", Penn Controls, Siemens Building Technologies, or approved equal.

Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45°F to 95°F (7°C to 35°C) with the following features:

- 7 day programming with 2 occupied/unoccupied periods per day.
- Automatic heat/cool changeover.
- Battery backup.
- Digital display.
- Temporary override of setpoints.
- 2 configurable LED's.

Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

2.4.02.02 Humidistats. Humidistats, denoted by the symbol "H" and an identifying number, shall be Honeywell "H46C", Johnson Controls, Siemens Building Technologies, or approved equal.

Humidistats shall have a nylon element coupled to a spst mercury contact that closes on a rise in relative humidity. Each humidistat shall have an adjustable range of 20 to 80 percent relative humidity and an operating differential of approximately 5 percent relative humidity.

2.4.02.03 Economizer Control System. A complete economizer control system shall be provided for the system as indicated in the sequence of operations on the drawings. The economizer control system shall be Honeywell "Model W6215", or approved equal. The economizer control system shall be electronic solid state type with logic module, temperature and enthalpy sensors as required for the application. The economizer system shall provide temperature, single enthalpy, or differential enthalpy control and shall be suitable for use with the space thermostat. The economizer control system shall be mounted in the temperature control panel associated with the controlled system.

2.4.03 Direct Digital Control Systems.

2.4.03.01 General. The Direct Digital Control (DDC) system shall be furnished and installed as indicated on the drawings and as specified herein. The DDC system shall be capable of integrating multiple HVAC system functions, including data sharing, alarm/event management, scheduling, trending, and device/network management.

The DDC system shall consist of, but shall not be limited to, the following:

Stand-alone system and zone level DDC controllers for control of air handling units, air terminal units, heating water system, and chilled water system.

A network bus for communication between controllers.

A network control unit (NCU), if necessary to accomplish the control strategies described in the Sequence of Operation.

Portable operator interface terminal.

Sensors, transmitters, detectors, and accessories necessary for proper operation of the system and equipment.

Personal computer as necessary for alarm management, configuration, and programming.

The system shall be of modular design, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC controllers, and operator devices.

The failure of any single component, including the NCU, or network connection shall not interrupt the execution of control strategies at other operational devices. Master controllers shall employ a spare control strategy to ensure control execution is not interrupted.

2.4.03.02 Networking/Communications. The DDC system shall be an integrated network system configured to perform the functions described in the sequence of operation. The system's design shall include provisions to expand or modify the network.

The DDC controllers and NCU shall be capable of full stand-alone operation allowing execution of control strategies with default values when bus communication and global data is not available. In addition, the controllers shall reside on the network so that communications may be executed directly to and between DDC controllers, and shall allow intelligent interface for program changes, command inputs, and output of operating data.

The digital control system shall allow all operator devices, either network resident or connected via dial-up modems, to access all point status and application report data on the network. Access to system data shall not be restricted by the hardware configuration of the DDC system.

When it would be inefficient or impractical to provide multiple sensors, the digital control system shall provide global data sharing or global point broadcasting between DDC controllers.

The network design shall provide:

Data transfer rates for alarm reporting and quick point status from multiple DDC controllers.

Support of any combination of DDC controllers. A minimum of 20 DDC controllers shall be supported on a single local network or control bus. The bus shall be addressable for up to 20 DDC controllers.

Detection of single or multiple failures of DDC controllers or the network media.

Error detection, correction, and re-transmission as necessary to guarantee data integrity.

Commonly available, multiple-sourced, networking components shall be used.

Use of an industry standard protocol, such as Optomux, and IEEE RS-485 communications interface at the network interface level.

Each DDC controller, air terminal unit zone thermostat, and the NCU, if provided, shall include provisions for connection to a portable operator's terminal which will allow the system operator to interface with the control network. The operator's terminal shall be mounted at the digital control panel as required, and shall be available for connecting to remote DDC controllers. The portable operator's terminal shall include a keypad and full English language display. A touchpad, menu-driven display shall also be acceptable. If the Echelon zone communication bus is utilized, then a 50 foot (15 m) operators terminal cable maybe provided in lieu of the room sensor jack connection.

The operator's terminal shall have multiple-level password access protection to allow the user to limit control, display, and data base manipulation capabilities for each user, based upon an assigned password. The passwords shall be exactly the same for all operator devices with a minimum of three levels of access. A minimum of 4 passwords shall be supported at each digital controller. The same passwords shall be used at any controller for the specific user.

Operators will be able to perform only the commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined for the access level of the password used to log-on. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

The operator interface shall allow the operator to perform commands including, but not limited to, the following:

Start up or shut down selected equipment.

Adjust setpoints.

Add/modify/delete time programming.

Enable/disable process execution.

Enable/disable totalization for each point.

Enter temporary override schedules.

Define holiday schedules.

Change time/date.

Enter/modify analog alarm limits.

Command controller outputs for maintenance/test operations.

View and acknowledge a minimum of the last 50 alarms.

2.4.03.03 System Software Features. All necessary software to form a complete operating system shall be provided as an integral part of the DDC system, and shall not be dependent upon a higher level computer for execution. As a minimum, the software shall include the following:

Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

Energy Management Applications: The DDC system shall be able to perform any or all of the following energy management routines:

- Time of Day Scheduling
- Calendar Based Scheduling
- Holiday Scheduling
- Optimal Start
- Optimal Stop
- Heating/Cooling Interlock
- Demand Limiting
- Load Rolling

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. The programs shall be applied to building equipment described in the Sequence of Operations.

Programming Capability: The DDC system shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.

Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

- Any system-measured point data or status
- Any calculated data
- Any results from other processes
- Boolean logic operators (and, or)

Process Triggers: Configured processes may be triggered based on any combination of the following:

- Time of day
- Calendar date
- Other processes
- Events (e.g., point alarms)

Data Access: A single process shall be able to incorporate measured or calculated data from any DDC controller and shall be able to issue commands to points in any and all other DDC controllers on the local network.

Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC controller and the NCU, if necessary, shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. Alarms shall be displayed and acknowledged via the portable operator's terminal or other device provided by the System Supplier.

The DDC system's ability to report alarms shall be affected neither by operator activity at the local I/O device, nor by communications with other DDC controllers on the network.

Point Change Report Description: All alarm or point change reports shall include a verbal description of the point and the time and date of occurrence.

Prioritizing: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

The user shall be able to identify the conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

Alarm Messages: In addition to the point description and the time and date, the user shall be able to display or store an alarm message to more fully describe the alarm condition or direct operator response. Each DDC controller shall be capable of storing at least 20 alarm messages. Each message may be assignable to any number of points in the panel.

2.4.03.04 DDC Controllers. Each DDC controller shall operate as a stand-alone controller capable of performing its specified control strategies independently of other controllers in the network. Each DDC controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.

Each DDC controller shall have sufficient memory to support its own operating system and data bases, including the following:

Control processes.

Energy management applications.

Operator I/O (portable service terminal).

The operator interface to any DDC controller point data or programs shall be through the portable operator's terminal connected to any DDC controller on the network. In addition, a communication bus shall be provided for connection to an Owner furnished personal computer. A software package and necessary interface card shall be furnished and installed on the computer to allow communication in text format with the DDC system.

DDC controllers shall directly support the temporary use of a portable service terminal that can be connected to the DDC controller via an input jack located on the zone temperature sensor or the controller. If the Eschelon Lonworks Bus is utilized at the terminal unit controller level, a portable bus control/display operator's terminal shall be provided. The capabilities of the portable service terminal shall include, but not be limited to, the following:

Display temperatures.

Display status.

Display setpoints.

Display control parameters.

Override binary output control.

Override analog setpoints.

Modification of gain and offset constants.

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the DDC controller.

Each controlled device or function shall be a separate output of the DDC controller.

2.4.03.04.01 Air Terminal Unit Controllers. Air terminal unit controllers shall be configured to support single duct cooling with hot water coil and remote hot water convective heating. The air terminal unit controllers shall support the following types of point inputs and outputs:

Cooling outputs (proportional).

Box heating outputs (proportional).

Air terminal unit controllers shall support the following library of control strategies to address the requirements of the sequences described in the sequence of operation and for future expansion:

Daily schedules.

Occupied/unoccupied mode.

Morning warm-up mode.

Temporary override mode.

Temporary comfort mode.

Boost (occupant warmer/cooler control).

The controller interface to the zone temperature sensor shall allow an optional momentary switch to change the mode of the controller from unoccupied to occupied mode.

The controller interface to the zone temperature sensor shall allow an optional momentary switch or setpoint pot to override the controller's output to full heating or cooling as necessary. This command shall be active for a preset amount of time to anticipate a substantial change in the room's heating or cooling load via set-point adjustment.

Continuous Zone Temperature Histories: Each air terminal unit controller shall automatically and continuously maintain a history of the associated zone temperature. This allows users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two temperature samples per hour shall be stored.

Alarm Management: Each air terminal unit controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

Direct digital control (DDC) panels associated with the air terminal units are not shown on the drawings but shall be located at the respective volume control unit location.

2.4.03.04.02 Air Handling Unit (AHU) Controllers. The AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the sequence of operation, and for future expansion:

Mixed air-single path.

VAV system, including supply and return fan speed control.

Heating and cooling control.

System economizer.

Low temperature safeties/shutdown sequence.

Smoke detection/purge/vent protection.

Supply and return airflow measurement.

User defined points alarming for:

a. High filter pressure loss.

b. High/low duct static pressure.

c. Freeze detection.

d. Smoke alarms.

AHU controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

AHU controllers shall have a library of control routines and program logic to perform the sequence of operation.

Each AHU controller shall automatically and continuously maintain a history of the associated zone temperature and air system temperatures to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

Each AHU controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.4.03.04.03 Heating Water System Controller. The heating water system controller shall support, but not be limited to, the following configurations of systems to address current requirements as described in the sequence of operation and for future expansion:

Boiler sequencing.

Boiler firing rate.

Boiler blending valve control.

Primary heating water loop temperature control.

Secondary heating water loop temperature control.

Heating water pump control.

User defined points alarming for:

a. High/low water temperature.

b. Low water flow.

The heating water system controller shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

The controller shall have a library of control routines and program logic to perform the sequence of operation.

The controller shall automatically and continuously maintain a history of the associated loop supply and return heating water temperature to allow users to quickly analyze equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

The controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.4.03.05 Sensors and Controllers.

Wall-Mounted Temperature Sensors. Space temperature sensors shall use a precision type accurate to ± 0.5°F (0.3°C) over a temperature range of 40°F to 90°F (5°C to 32°C). The assembly shall be installed within a ventilated off white enclosure suitable for wall mounting. The output shall be compatible with the controller it serves. Where manual overrides are indicated, the sensor shall include push button override capability, thermometer or temperature indication, sliding warmer/ cooler mechanism for adjusting the temperature setpoint, and latching cover.

Duct-Mounted Temperature Sensors. Duct-mounted temperature sensors installed in ducts smaller than 10 square feet (0.92 square meters) shall be a single point type. Duct-mounted temperature sensors installed in ducts greater than 10 square feet (0.92 square meters) or subject to temperature stratification shall be averaging type. Sensors shall be a general purpose type with an operating range as needed for the application and an accuracy of ± 1 percent over the full range. The output shall be compatible with the controller it serves.

Pipe Insertion Temperature Sensors. Pipe insertion temperature sensors shall contain a sensing element with an operating range as needed for the application and an accuracy of ± 1 percent over the full range. The sensors shall be installed in brass or stainless steel thermal wells of sufficient size with a minimum insertion length of 2-1/2 inches (65 mm). The output shall be compatible with the controller it serves.

Wall-Mounted Humidity Sensors. Wall-mounted humidity sensors shall be capable of providing continuous measurement of percent relative humidity with an accuracy of ± 5 percent over the range of 10 to 80 percent RH. The assembly shall be installed within a enclosure matching the wall thermostat cover. The output shall be compatible with the controller it serves.

Duct-Mounted Humidity Sensors. Duct-mounted humidity sensors shall be capable of providing continuous measurement of percent relative humidity with an accuracy of ± 3 percent over the range 20 to 90 percent RH. Sensors located outdoors shall be installed in a weather enclosure. The output shall be compatible with the controller it serves.

Pressure Sensors. Pressure sensors shall be suitable for air or water service. Accuracy shall be ± 1 percent of full scale. The unit shall have temperature compensation so that thermal effects are no more than ± 0.5 percent of the full scale from 32 to 100°F. The transmitter shall be suitable for the media and pressure measured.

2.4.04 Temperature Control Panels. Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be NEMA Type 12 designed for wall mounting and shall be completely prewired and checked. Temperature control panel enclosures shall be manufactured by Hoffman Engineering, Integration Technology Systems Inc, or Par Metal Products Inc.

All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm and indicating lights, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel.

Accessories such as indicating lights and selector switches shall be mounted on the hinged front covers of the panels. The accessories and panels shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panels with corrosion resistant pan head screws.

Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, smoke detectors, and valves. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operations on the drawings.

All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture and flame-resistant covering rated for at least 90°C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Secondary power distribution wiring, wiring for control circuits, and annunciator and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the color coding legend on the panel wiring diagrams.

Selector Switches. Selector switches shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Selector switches shall be heavy-duty oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.

Push Buttons. Push buttons shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

Indicating Lights. Indicating lights shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Alarm, indicator, and running status lights shall be furnished with bulbs. Indicating lights shall be heavy-duty, push-to-test, oiltight type with low voltage bulbs and built-in transformers. Legends shall be engraved on the lens or on a legend faceplate. Bulbs shall be easily replaceable from the front of the device.

Alarm Horns. Alarm horns shall be Federal Signal "Model 350", or approved equal. Alarm horns shall have a sound output of 100 dB at 10 feet (3 m) and shall be rated for 120 volts ac. Horns shall be furnished with mounting hardware suitable for flush mounting.

Relays. Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; Struthers-Dunn "Series A3, A4", or approved equal. Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or engraved switch settings marked in seconds and shall have timing repeatability of ± 2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

Terminal Blocks and Panel Wiring. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.

Control Power Transformers. Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.

Terminals. A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches (203 mm) of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.

All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of their depth remaining for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with universal primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils (100 μm). One quart (0.95 L) of paint shall be furnished with the panels for future touchup painting.

2.4.05 Temperature Indicators.

2.4.05.01 Dial Thermometers. A dial thermometer shall be supplied and installed at each remote bulb sensor for calibration and calibration checks. The range of the dial thermometers shall be -40°F to 120°F (-40°C to 49°C).

In ducted systems containing hydronic coils or electric duct heaters, a dial thermometer shall be furnished and installed on the downstream side of the coil or heater. Thermometers shall be complete with averaging type elements.

2.4.05.02 Electronic Temperature Transmitters. Electronic temperature transmitters shall be furnished to transmit an electronic signal to a controller as indicated in the sequence of operation. The signal shall be compatible with the controller. Sensors shall be calibrated at the temperature control manufacturer's factory. Field adjustable sensors shall be used, with a dial thermometer installed adjacent to each sensor for calibration checks. The sensors shall have a temperature range of at least -20°F to 75°F (-7°C to 24°C).

2.4.06 Smoke Detectors. Smoke detectors, denoted by the symbol "SMD" and an identifying number, shall be System Sensor "DH100", Simplex, Grinnell, or approved equal.

Detectors shall be designed to detect combustion gases, fire, and smoke in air conditioning and ventilating duct systems in compliance with the NFPA 90A and shall contain a detector and air sampling chamber which serves as a reference point to help stabilize the detector against the effects of changes in temperature, humidity, and pressure.

Smoke detectors shall be duct-mounted photoelectric type and shall be completely self-contained, including integral power supply, supervisory and control circuitry and three sets of isolated contacts. The alarm contact shall be spst normally open; the auxiliary alarm contact shall be spdt, and the trouble contact shall be spdt and shall indicate detector malfunction. The alarm and trouble contacts shall be rated 2 amperes at 30 volts dc. The auxiliary alarm contact shall be rated 10 amperes at 120 volts ac. Pilot lights shall be provided for visual indication of alarm and power supply status on the front of the unit. A remote key-operated test station with alarm light and power supply status shall also be furnished and installed where indicated on the drawings. Detectors shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply.

Detectors shall be provided with sampling tubes extending the width of the air duct.

2.4.07 Pressure Differential Switches. The pressure differential switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Initial setpoints shall be as indicated on the drawings. Differential switches shall be UL listed.

Where indicated on the drawings, pressure differential switches shall be provided with an explosionproof housing suitable for a NEC Class 1, Division 2, Group D environment. Where pressure differential switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided.

2.4.07.01 Differential Airflow Switches. Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800", or approved equal.

Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spst, shall be rated 5 amperes at 120 volts ac and for a temperature range of -20°F to 125° F (-29° C to 52°C), and shall be provided with corrosion resistant mounting brackets. Pressure differential switches located across filters shall be initially set at the following setpoints.

Filter Type	Setpoint
1 inch (25 mm) pleated	0.75 inch wc (186 Pa)
2 inch (50 mm) pleated	1.0 inch wc (250 Pa)

Extended Surface	1.2 inch wc (300 Pa)

2.4.07.02 Differential Water Flow Switches. Pressure differential water flow switches shall be Mercoid "Series DP", or approved equal.

Differential pressure switches for water service shall be diaphragm operated by differential pressure. The switches shall be single pole double throw, bellows operated, suitable for 100 psig (690 kPa) working pressure, and shall be rated 15 amperes at 120 volts ac.

2.4.08 Water Flow Switches. Water flow switches, denoted by the symbol "FS" and an identification number, shall be furnished and installed as indicated on the drawings. Switches shall be W.E. Andersen "Model V4-2-U", or approved equal.

Water flow switches shall be spdt, operated by vane motion through a magnetic link. The flow switch body shall be brass with Type 316 stainless steel vane. The flow switch shall be rated for 275°F (135°C) and 150 psig (1034 kPa) service. Piping connection shall be 1-1/2 inch (40 mm) NPT. Switch contacts shall be rated at 5 amperes at 120 volts ac. The water flow switches shall be suitable for mounting in the hydronic system piping as indicated on the drawings.

2.4.09 Control Stations. Control stations for high rate ventilation fans shall include a two position selector switch with nameplate labeled "High Rate Ventilation On/Off". Control stations shall also include two indicating lights for "On/Off" indication. Indicating lights and selector switches shall be heavy duty oiltight NEMA Type 13. The control station enclosure shall be NEMA Type 4. Control stations shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.4.10 Emergency Ventilations Shutoff Switches. Emergency ventilation shutoff switches shall be furnished and installed where indicated on the drawings. The switches shall be Square D, Emergency Break-glass Operator "9001K15", or approved equal. Each break-glass switch for HVAC emergency shutoff shall be furnished with a NEMA Type 4 stainless steel enclosure with hammer, hammer clip, and chain. Each switch shall have one normally open and one normally closed contact block. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position to de-energize the equipment. Nameplates shall be provided as indicated on the on-line diagrams. The switches shall be provided with phenolic nameplates identifying the switches as 'VENTILATION SYSTEM EMERGENCY SHUTOFF."

2.4.11 Control Valves. Modulating control valves shall be sized for a pressure drop of at least 5 psig (35 kPa) and not more than 10 psig (69 kPa) at design flow. Control valves shall be modulating two-way or three-way as indicated in the schedule and on the drawings. Two inch (5.08 cm) and smaller valves shall have bronze bodies and threaded connections. Two and a half inch (6.35 cm) and larger valves shall have cast iron bodies and flanged ends.

Modulating valves shall be equipped with throttling plugs and removable discs and electric actuators or shall be refrigerant pressure actuated as specified herein and as indicated on the drawings. Refrigerant pressure actuated valves shall be suitable for use with the chiller refrigerant.

Modulating electric valve actuators shall be equipped with a proportional, reversing motor which shall produce a linear relationship between valve lift and valve flow at constant pressure drop. Each actuator shall have an internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Actuators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where needed shall be factory wired to the actuator and installed in a NEMA Type 3R enclosure secured to the motor housing.

Valves shall be furnished with linkage bolted directly to the bonnet and motor flange.

2.4.12 Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2.5 CONSTRUCTION.

2.5.01 Shop Painting. Unless otherwise indicated, shop painting shall be as specified in the General Equipment Stipulations. Surface finish damaged during installation shall be repaired to the satisfaction of the Engineer. Field painting shall conform to the requirements of Master Specification Section 09900, Painting.

2.5.02 Control Circuits. Control wiring shall be in accordance with the National Electrical Code (NEC). Conduit for all HVAC control circuits shall be EMT, except in areas designated on the electrical drawings as Area Type 1A, Area Type 4, or Area Type 12. In areas designated Type 1A conduit shall be exposed rigid PVC non-metallic conduit with PVC fittings, boxes, and accessories. In areas designated Type 4 and Type 12, conduit shall be IMC with gasketed enclosures and fittings. All conduit and conduit installation shall be in accordance with the requirements of Master Specification Section 16050, Electrical General Requirements and the NEC.

2.6 CABLE AND RACEWAYS.

2.6.01 Cable. Cable used in the temperature control system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations. All cable necessary for the system, except 120 volt ac power, shall be furnished by the System Supplier.

2.6.02 Raceways. All cable shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of Master Specification Section 16050, Electrical General Requirements.

2.7 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

Typical schematics on the drawings indicate electrical control items and functions necessary for most of the equipment; however, actual motor sizes shall comply with Master Specification Section 16220, General Purpose Induction Motors.

2.8 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories needed for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.9 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the drawings. Control equipment shall be installed with adequate operating and maintenance access space.

3.2.01 Temperature Control Panels. The panels shall be mounted so that selector switches and indicating lights on the panel are located approximately 5 feet (1.5 m) above the finished floor.

3.2.02 Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in Master Specification Section 16050, Electrical General Requirements. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in nonairconditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3.2.03 Damper Operators. The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position, face dampers shall fail to the closed position, and bypass dampers to the open position.

3.2.04 Device Tag Numbering System. All devices shall be provided with permanent identification tags numbered to agree with the manufacturer's equipment drawings. All field-mounted control devices shall bear securely fastened identification tags. Hand-lettered labels or tape will not be acceptable.

Phenolic nameplates shall be provided and permanently attached to the wall at each control device to indicate the equipment controlled. The letters used shall be the same as the equipment designations indicated herein and on the drawings. Nameplates shall have white letters on black backgrounds.

3.2.05 Control Valves. Three-way hot water valves shall fail open to the heating coil unless otherwise indicated. Three-way chilled water valves shall fail open to the bypass unless otherwise indicated.

3.2.06 Cable. Cable shall be installed in conduit as described in the cable installation paragraphs in Master Specification Section 16050, Electrical General Requirements. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

3.2.07 Raceways. Conduit shall be installed as described in the conduit installation paragraphs in Master Specification Section 16050, Electrical General Requirements.

3.3 FIELD QUALITY CONTROL.

3.3.01 Installation Check. An experienced, competent, and authorized representative of the temperature controls supplier shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3.02 Field Testing. After the installation of the equipment and systems has been completed, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.4 ADJUSTING. The building system controls supplier shall provide initial startup and adjustment of the control systems, instruction of operating personnel, and set point maintenance for one year.

The building system controls supplier shall be responsible for establishing the final control system settings necessary for proper operation of the equipment and systems. These settings and calibration shall have the concurrence of the equipment manufacturer's representative.

The building system controls supplier shall demonstrate to Owner the complete and correct functioning of all control systems and equipment, and shall make all necessary repairs, replacements, or adjustments to items which fail to perform to the satisfaction of the Owner.

3.5 CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to the Owner.

3.6 OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

SECTION 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SCOPE. This section covers the cleaning, testing, adjusting, and balancing of the air and water systems associated with the heating, ventilating, and air conditioning (HVAC), emergency gas treatment system and odor control systems, as indicated in the Contract Documents.

1.2 GENERAL. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each air or hydronic system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

Hydronic systems shall be complete and operating, with valves, coils, pumps, piping, and control components, and shall be cleaned, filled, and vented. All strainers shall be checked for installation of the appropriate basket and shall be cleaned.

1.2.02 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air and hydronic systems.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete apparatus report sheets for all air or hydronic systems shall be accurately and completely filled out in accordance with the Standard's manual. Copies of the final test readings and report sheets shall be submitted in accordance with the Master Specification Section 01080, Project

Submittals. As indicated in the Contract Documents, a description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets.

The apparatus report sheets shall include the following information:

1. Title Page:
   a. Company name.
   b. Company address.
   c. Company telephone number.
   d. Project name.
   e. Project location.
   f. Project Engineer.
   g. Project Contractor.
   h. Project altitude.
2. Instrument List:
   a. Instrument.
   b. Manufacturer.
   c. Model.
   d. Serial number.
   e. Range.
   f. Calibration date.
3. Air Moving Equipment:
   a. Location.
   b. Manufacturer.

c. Model.

d. Airflow, specified and actual.

e. Return airflow, specified and actual.

f. Outside airflow, specified and actual.

g. Total static pressure (total external), specified and actual.

h. Inlet pressure.

i. Discharge pressure.

j. Fan RPM.

4. Return Air/Outside Air Data:

a. Identification/location.

b. Design airflow.

c. Actual airflow.

d. Design return airflow.

e. Actual return airflow.

f. Design outside airflow.

g. Actual outside airflow.

h. Return air temperature.

i. Outside air temperature.

j. Required mixed air temperature.

k. Actual mixed air temperature.

l. Design outside/return air ratio.

m. Actual outside/return air ratio.

5. Electric Motors:

a. Manufacturer.

b. HP/BHP.

c. Phase, voltage, amperage; nameplate, actual, no load.

d. RPM.

e. Service factor.

f. Starter size, rating, heater elements.

6. V-Belt Drive:

a. Identification/location.

b. Required driven RPM.

c. Driven sheave, diameter, and RPM.

d. Belt, size, and quantity.

e. Motor sheave, diameter, and RPM.

f. Center to center distance, maximum, minimum, and actual.

7. Duct Traverse:

a. System zone/branch.

b. Duct size.

c. Area.

d. Design velocity.

e. Design airflow.

f. Test velocity.

g. Test airflow.

h. Duct static pressure.

i. Air temperature.

j. Air correction factor.

8. Air Distribution Test Sheet:

a. Air terminal number.

b. Room number/location.

c. Terminal type.

d. Terminal size.

e. Area factor.

f. Design velocity.

g. Design air flow.

h. Test (final) velocity.

i. Test (final) airflow.

j. Percent of design airflow.

9. Air Terminal Unit Data:

a. Manufacturer.

b. Type, constant, variable, single.

c. Identification/number.

d. Location.

e. Model.

f. Size.

g. Minimum static pressure.

h. Minimum design airflow.

i. Maximum design airflow.

j. Maximum actual airflow.

k. Inlet static pressure.

10. Electric Duct Heater:

a. Manufacturer.

b. Identification/number.

c. Location.

d. Model.

e. Design kW.

f. Number of stages.

g. Phase, voltage, amperage.

h. Test voltage (each phase).

i. Test amperage (each phase).

j. Airflow, specified and actual.

k. Temperature rise, specified and actual.

11. Pump Data:

a. Identification/number.

b. Manufacturer.

c. Size/model.

d. Impeller.

e. Service.

f. Design flow rate, pressure drop, BHP.

g. Actual flow rate, pressure drop, BHP.

h. Discharge pressure.

i. Suction pressure.

j. Total operating head pressure.

k. Shut off, discharge and suction pressures.

l. Shut off, total head pressure.

12. Chillers:

a. Identification/number.

b. Manufacturer.

c. Capacity.

d. Model.

e. Evaporator entering water temperature, design and actual.

f. Evaporator leaving water temperature, design and actual.

g. Evaporator pressure drop, design and actual.

h. Evaporator water flow rate, design and actual.

i. Condenser entering water temperature, design and actual.

j. Condenser leaving water temperature, design and actual.

k. Condenser pressure drop, design and actual.

l. Condenser water flow rate, design and actual.

13. Air Cooled Condenser:

a. Identification/number.

b. Location.

c. Manufacturer.

d. Model.

e. Entering DB air temperature, design and actual.

f. Leaving DB air temperature, design and actual.

g. Number of compressors.

14. Heat Exchanger:

a. Identification/number.

b. Location.

c. Service.

d. Manufacturer.

e. Model.

f. Primary water entering temperature, design and actual.

g. Primary water leaving temperature, design and actual.

h. Primary water flow, design and actual.

i. Primary water pressure drop, design and actual.

j. Secondary water entering temperature, design and actual.

k. Secondary water leaving temperature, design and actual.

l. Secondary water flow, design and actual.

m. Secondary water pressure drop, design and actual.

15. Coil Data:

a. Identification/number.

b. Location.

c. Service.

d. Manufacturer.

e. Airflow, design and actual.

f. Entering air DB temperature, design and actual.

g. Entering air WB temperature, design and actual.

h. Leaving air DB temperature, design and actual.

i. Leaving air WB temperature, design and actual.

j. Water flow, design and actual.

k. Water pressure drop, design and actual.

l. Entering water temperature, design and actual.

m. Leaving water temperature, design and actual.

n. Air pressure drop, design and actual.

16. Sound Level Report:

a. Location.

b. Octave bands - equipment off.

c. Octave bands - equipment on.

17. Combustion Test:

a. Boiler manufacturer.

b. Model.

c. Firing rate.

d. Overfire draft.

e. Gas pressure at meter outlet.

f. Gas flow rate.

g. Heat input.

h. Burner manifold gas pressure.

i. Percent carbon monoxide (CO).

j. Percent carbon dioxide (CO_2).

k. Percent oxygen (O_2).

l. Percent excess air.

m. Flue gas temperature at outlet.

n. Ambient temperature.

o. Net stack temperature.

p. Percent stack loss.

q. Percent combustion efficiency.

r. Heat output.

Product data indicating cleaning materials and treatment, chemicals, and reports on the analysis of system water after cleaning and after treatment, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals.

1.4 QUALITY ASSURANCE. Contractor shall provide the services of a licensed independent contractor, certified by AABC or NEBB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air or hydronic systems. The total system balance shall be performed in accordance with AABC, SMACNA, or NEBB Procedural Standards for the work.

1.5 MAINTENANCE. Contractor shall provide the services of a company specializing in water analysis and chemical treatment with at least 3 years of documented experience. The company shall have local representation with water analysis laboratories and full-time service personnel.

The water treatment company shall provide laboratory services and technical assistance for one year from the date of substantial completion of the project. At the completion of the service period, the water treatment company shall conduct a 4 hour training course to instruct facility operating personnel in system maintenance, testing methods, and chemical water treatment procedures.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the Contract Documents.

2.2 CONSTRUCTION.

2.2.01 Painting. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field coatings shall be as specified in Master Specification Section 09900, Painting.

2.3 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

PART 3 - EXECUTION

3.1 INSPECTION. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Fire and smoke dampers shall be open and access doors and panels shall be closed during the testing and balancing. A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type	Simulated Loss
1 inch (25 mm) pleated	0.15 inch water column (37 Pa)
2 inch (50 mm) pleated	0.35 inch water column (87 Pa)
Extended surface	0.80 inch water column (200 Pa)

Before starting the hydronic system testing and balancing, all valves and control components shall be opened or set to direct flow through the heat transfer element. The pumps shall be checked for correct rotation and rotative speed.

3.2 STARTUP REQUIREMENTS. System equipment shall be subject to preliminary field tests as indicated.

3.3 FIELD PERFORMANCE TESTING. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
1 inch (25 mm) pleated	0.75 inch water column (186 Pa)
2 inch (50 mm) pleated	1.0 inch water column (250 Pa)
Extended surface	1.2 inch water column (300 Pa)

3.3.01 Hydronic Piping. The hydronic piping systems shall be hydrostatically tested in accordance with ANSI/ASME B31.9.

All equipment or accessories which are connected to the piping systems, and which would be damaged if subjected to the specified test pressure, shall be disconnected and the ends of the branch lines shall be plugged or capped as needed during the testing procedure.

All hydronic piping shall be hydrostatically tested at a test pressure not less than 1.5 times the working pressure, and not less than 50 psi (345 kPa).

3.3.02 Refrigerant Piping. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.

After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.

The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent.

3.4 CLEANING. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3.4.01 Piping. Piping shall be cleaned with a liquid alkaline compound consisting of emulsifying agents and detergents conforming to applicable codes governing the addition of nonpotable chemicals to the buildings' mechanical systems and their discharge to public sewerage systems. All terminal control valves shall be placed in the open position during cleaning. The cleaning agent shall be added to the closed hydronic systems at the concentrations recommended by the cleaner manufacturer.

After piping systems have been cleaned, they shall be flushed with a neutralizing agent recommended by the cleaner manufacturer. All strainer screens in the piping systems shall be removed, cleaned, and replaced.

After the completion of the flushing and neutralizing, the piping systems shall be inspected and any remaining sludge shall be removed. This inspection shall include disassembly of components if necessary.

3.4.01.01 Heating Water System. While the cleaning solution is circulating in the system, it shall be slowly heated to 160°F (71°C) and maintained at that temperature for at least 12 hours. The heating shall then be stopped and the temperature of the circulating solution shall be allowed to drop to 100°F (38°C). The system shall then be drained as rapidly as possible and shall be refilled with clean water. The clean water shall be circulated for 6 hours at design temperatures and then drained. The system shall again be filled with clean water and the procedure repeated until all cleaning solution is removed.

3.4.01.02 Chilled and Condenser Water Systems. The cleaning solution shall be circulated in the system for 48 hours, and then drained as rapidly as possible. The system shall then be filled with clean water, which shall be circulated for 24 hours, and drained. The sequence of rinsing with clean water shall be repeated until all cleaning solution is removed.

3.4.02 Hydronic Systems. After the hydronic system has been cleaned, it shall be filled with clean potable water and immediately treated with the appropriate chemicals. The treatment chemicals shall be suitable for use at the system operating temperature and shall be compatible with the system construction materials of steel, cast iron, stainless steel, and copper alloys.

The water treatment chemicals shall conform to applicable codes governing the addition of nonpotable chemicals to the buildings' mechanical systems and their discharge to public sewerage systems. Sufficient treatment chemicals shall be furnished for the duration of the services period.

Chemical treatment of the hydronic system shall consist of applying corrosion inhibitors, conductivity enhancers, and sequestering agents to reduce deposits and adjust pH.

3.5 ADJUSTING & BALANCING. After completion of the hydronic system chemical treatment, the air and hydronic systems shall be adjusted and balanced.

All instrumentation shall be calibrated within 6 months of use and shall be checked for accuracy before testing, adjusting, and balancing the air and hydronic systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.

All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

3.5.01 Air Systems. Air systems shall be adjusted to the design airflows indicated on the drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not create objectionable air movement or noise.

Dampers with operators shall be checked for tight shutoff when in the closed position.

3.5.02 Hydronic Systems. The hydronic systems shall be adjusted to the design flow rates indicated on the drawings. Equipment or system shutoff valves shall not be used for flow rate adjustment.

End of Section

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SECTION 15005

MECHANICAL DEMOLITION

PART 1 – GENERAL

1.1 SCOPE. Perform all HVAC, demolition required for removal of systems and equipment made obsolete by project as indicated on the drawings and as specified herein.

Work Included:

Non-destructive and selective removal of systems, materials, and equipment for reuse or salvage as directed by the Owner and as requested by the Engineer.

Removal and legal disposal of all debris.

Removal of all obsolete materials and equipment for a clean and finished installation, unless noted otherwise on the drawings.

Removal of existing heating and ventilating (H&V) equipment and piping as shown on contract documents and as required in field if not shown on contract documents.

The existing heating and ventilating (H&V) demolition work shall include demolition of controls, exhaust fans, louvers, ductwork, existing steam/condensate piping as shown on plans and as specified here. This, therefore, will require selective removal/demolition and capping at the mains.

The Contractor shall cap existing piping that is not being reused as shown on plans or as required.

The HVAC Contractor to remove existing thermostats and conduits as required and patch openings. Match finish with existing finish.

The HVAC Contractor shall perform demolition of respective systems and all cutting/patching of holes and restoration of all surfaces (floors, walls, ceilings, roof, etc.) to match with existing adjacent surfaces as clearly as possible as to texture and finish.

The cutting/patching shall be done by craftsman skilled in particular trade affected by demolition.

Insulation or materials shall be identified before attempting any demolition. Contractor shall comply with the requirements of EPA regulations, National Emissions Standards, and the OSHA regulations, as well as applicable State laws and City Codes and Ordinances.

1.2 GENERAL. Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.3 JOB CONDITIONS.

1.3.01 Coordination. Adjacent buildings will be required to remain in operation and utility services will be required to be maintained for operations in those buildings.

1.3.02 Phasing. Prior to commencing demolition in any area of the work, notify the Owner/Architect seven days in advance to ensure that no adjacent occupied buildings will be disrupted. All shutdowns, if required, shall be scheduled with the utility companies. Where shutdowns are not permitted during weekdays/working hours, the Contractor shall do such work on the weekends or after working hours. All such costs for premium time shall be included in the bid. Refer to phasing plans in the bidding documents before starting work.

Demolition phasing must be approved by the Owner prior to commencement of the operations.

Removal of debris and construction traffic will be limited to specified areas.

Demolition and installation phasing shall be worked out by the Contractor to maintain existing services to other buildings on site.

1.3.03 Codes. In addition to complying with all pertinent codes and regulations, comply with the requirements of those insurance carriers providing coverage for this work.

1.3.04 Burning. On site burning shall not be permitted.

During the execution of the work, primary consideration shall be given to the protection from damage to the structure, furnishings, finishes, and the like that are not specifically indicated to be removed and disposed.

Provide and maintain temporary partitions or dust barriers adequate to keep dirt, dust, noise, and other particles from being transferred to adjacent areas.

Existing items or surfaces to remain that are damaged as a result of this work shall be refinished, repaired, or replaced to the satisfaction of the Owner at no additional cost.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Patching. All materials used for patching shall be in conformance with the applicable sections of the specifications. Where materials are not specifically described, but require for proper completion of the work, they shall be as selected by the Contractor subject to approval by the Owner.

PART 3 - EXECUTION

3.1 DEMOLITION.

3.1.01 Site Inspection. The drawings do not show all materials or equipment existing on the project that will require demolition.

Before commencing the work of this section, the Contractor shall check with the Owner about materials, and equipment to be removed and those to be preserved. All those items requiring demolition shall be hauled away from site.

3.1.02 Scheduling. Schedule all work with all necessary considerations for public and adjacent areas.

Avoid interference with the use of and passage to and from adjacent areas.

Schedule all work so as not to interfere with nor disrupt Owners continuous operation of other areas of the facility.

All piping/ductwork that are partly removed and are required for making connections to new piping and ductwork shall be temporarily capped until new connections are made.

3.1.03 Abandoned Materials and Equipment. Items so indicated on drawings to be removed and not indicated or specified to be saved or retained shall be demolished, removed, demounted, or disconnected in the best possible manner to ensure that no damage will result to other adjacent items or surface to remain.

3.1.04 Salvage. During removal of items so indicated, caution shall be used to eliminate damage to any equipment having salvage value.

All material being removed shall become the property of the Contractor for disposal unless otherwise noted or directed. Deliver any such item retained by the Owner to any location on the project site as indicated by the project manager.

3.1.05 Disposal and Clean Up. Areas in which demolition and salvage work is being done shall be cleaned daily.

All dirt, dust, debris, unsalvageable and unreusable items and the like shall be totally removed from the project site on a daily basis. Under no circumstances shall such refuse be allowed to collect for longer periods.

Refuse shall not be allowed to block, or otherwise impair circulation in sidewalks or other traffic areas.

End of Section

SECTION 15006

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of mechanical identification materials for the mechanical equipment, piping and ducts as indicated in the contract documents:

Equipment nameplates.

Equipment markers.

Equipment signs.

Access panel and door markers.

Pipe markers.

Duct markers.

Valve tags.

1.2 SUBMITTALS. Submit a shop drawing of each type of product indicated above for engineer's approval.

Submit a typewritten valve schedule for each piping system, reproduced on 8 1/2 inch by 11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in the schedule margin.

Submit samples of each color, lettering style, and other graphic representation required for each identification material or system. Provide a mock-up type sample installation.

1.3 QUALITY ASSURANCE.

1.3.01 ASME Compliance. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES.

2.1.01 Equipment Nameplates. Metal, with data engraved or stamped, for permanent attachment on equipment.

Data:

Manufacturer, product name, model number, and serial number.

Capacity, operating and power characteristics, and essential data.

Labels of tested compliances.

Location:

Accessible and visible.

Fasteners:

As required to mount on equipment.

2.1.02 Equipment Markers. Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

Terminology:

Match schedules as closely as possible.

Data:

Name and plan number.

Equipment service.

Design capacity.

Other design parameters such as pressure drop, entering and leaving conditions, and speed.

Size:

2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.1.03 Equipment Signs. ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

Data:

Instructions for operation of equipment and for safety procedures.

Engraving:

Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

Thickness:

1/8 inch, unless otherwise indicated.

Fasteners:

Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.1.04 Access Panel and Door Markers. 1/16-inch- thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

Fasteners:

Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES.

2.2.01 Manufactured Pipe Markers, General. Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

Colors:

Comply with ASME A13.1, unless otherwise indicated.

Lettering:

Use piping system terms indicated and abbreviate only as necessary for each application length.

Pipes with OD, Including Insulation, Less Than 6 Inches:

Full-band pipe markers extending 360 degrees around pipe at each location.

Pipes with OD, Including Insulation, 6 Inches and Larger:

Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

Arrows:

Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

2.2.02 Pre-tensioned Pipe Markers. Pre-coiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

2.2.03 Shaped Pipe Markers. Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.2.04 Self-Adhesive Pipe Markers. Plastic with pressure-sensitive, permanent-type, self-adhesive back.

2.2.05 Plastic Tape. Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

2.3 DUCT IDENTIFICATION DEVICES.

2.3.01 Duct Markers. Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS.

2.4.01 Valve Tags. Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

Material: 0.032-inch- thick brass.

Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 ACCEPTABLE MANUFACTURERS. Identification materials shall be manufactured by All Systems, Inc., Brady (W.H.) Co., Marking Services, Inc., Seton Name Plate Corp., or equal.

PART 3 – EXECUTION

3.1 APPLICATIONS, GENERAL. Products specified are for applications referenced in other Division 15 Sections. If more than single-type material, device, or label is specified for listed applications, selection is installer's option.

3.2 EQUIPMENT IDENTIFICATION.

3.2.01 Equipment Nameplates. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

Pumps, compressors, chillers, condensers, and similar motor-driven units.

Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

Fans, blowers, primary balancing dampers, and mixing boxes.

Heating and ventilation central-station and zone-type units.

3.2.02 Equipment Markers. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

Letter Size:

Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Data:

Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

Location:

Locate markers where accessible and visible. Include markers for the following general categories of equipment:

Main control and operating valves, including safety devices and hazardous units such as gas outlets.

Meters, gages, thermometers, and similar units.

Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

Pumps, compressors, chillers, condensers, and similar motor-driven units.

Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

Fans, blowers, primary balancing dampers, and mixing boxes.

Heating and ventilation central-station and zone-type units.

Tanks and pressure vessels.

Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.2.03 Equipment Signs. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

Color:

Identify mechanical equipment with equipment markers in the following color codes:

Green: For cooling equipment and components.

Yellow: For heating equipment and components.

Green and Yellow: For combination cooling and heating equipment and components.

Brown: For energy-reclamation equipment and components.

Letter Size:

Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Data:

Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

Include signs for the following general categories of equipment:

Main control and operating valves, including safety devices and hazardous units such as gas outlets.

Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

Pumps, compressors, chillers, condensers, and similar motor-driven units.

Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

Fans, blowers, primary balancing dampers, and mixing boxes.

Heating and ventilation central-station and zone-type units.

Tanks and pressure vessels.

Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

3.2.04 Access Panel Markers. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION.

3.3.01 Manufactured Pipe Markers. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

Pipes with OD, Including Insulation, Less Than 6 Inches: Pre-tensioned pipe markers. Use size to ensure a tight fit.

Pipes with OD, Including Insulation, Less Than 6 Inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

Pipes with OD, Including Insulation, 6 Inches and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches wide, lapped at least 3 inches at both ends of pipe marker, and covering full circumference of pipe.

Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

> Near each valve and control device.
>
> Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
>
> Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
>
> At access doors, manholes, and similar access points that permit view of concealed piping.
>
> Near major equipment items and other points of origination and termination.

Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION.

3.4.01 Duct Markers. Install duct markers with permanent adhesive on air ducts in the following color codes:

Color:

Green: For cold-air supply ducts.

Yellow: For hot-air supply ducts.

Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

Letter Size:

Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.5.01 Valve-Tag Application Schedule. Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

Valve-Tag Size and Shape:

Cold Water: 1-1/2 inches, round.

Hot Water: 1-1/2 inches, round.

Steam & Condensate: 1-1/2 inches, round.

Valve-Tag Color:

Cold Water: Blue

Hot Water: Red

Letter Color:

Cold Water: Black.

Hot Water: Black.

3.6 ADJUSTING AND CLEANING. Relocate mechanical identification materials and devices that have become visually blocked by other work.

Clean faces of mechanical identification devices and glass frames of valve schedules.

End of Section

SECTION 15010

VALVE INSTALLATION

PART 1 - GENERAL

1.1 SCOPE. This section covers the installation of new valves and actuators purchased by Contractor as part of this Work, or purchased by others under the procurement specifications. The equipment to be furnished by others for installation by Contractor is identified in the applicable valve schedules.

Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

1.2 GENERAL. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Any valves and actuators that are identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

Contractor shall determine the number of handwheel turns to close each manual valve and shall provide a type 316 stainless steel nameplate, attached to the operator, to indicate the required turns. Contractor shall also submit to Engineer, a table, indicating the number of turns required for each manual valve provided.

1.2.01 Coordination. When manufacturer's field services or installation check services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services.

Submittals for equipment that will be furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

Flanged connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section.

1.3 DELIVERY, STORAGE, AND HANDLING.

1.3.01 Storage. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and the manufacturer's instructions until installed in the Work. Stored equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come into contact with earth or grass. Contractor shall keep the equipment dry at all times.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSPECTION. All valves and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 INSTALLATION.

3.2.01 General. Valves shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.

Unless otherwise indicated on the drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches (1.3 m) or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of piping having centerline elevations between 4 feet 6 inches (1.3 m) and 6 feet 9 inches (2 m) above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems oriented to facilitate the most practicable operation, as reviewed by Engineer.

3.2.02 Installation Checks. When specified in Master Specification Section 15010, Valve Installation, installation checks will be provided by a manufacturer's representative in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Such services shall be furnished at no charge to Contractor for the extent indicated in the valve procurement sections. Any additional services in connection with the installation the equipment which are required by reason of Contractor's progress shall be paid for by Contractor.

Contractor shall perform no Work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

3.2.03 Butterfly Valves. Butterfly valves shall be installed with the shaft horizontal unless otherwise necessary for proper operation or as acceptable to Engineer.

Whenever an actuator must be removed to permit installation of a valve, the actuator shall be promptly reinstalled and shall be inspected and readjusted by a representative of the valve manufacturer.

3.2.04 Check Valves.

3.2.04.01 Lift Check Valves. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.

3.2.04.02 Swing Check Valves. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.

3.2.05 Eccentric Plug Valves. Eccentric plug valves shall be installed with the shaft horizontal and the plug in the upper half of the valve body. Valves in wastewater, sludge, or scum lines shall be installed with the seat on the upstream end.

3.2.06 Resilient Seated Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendix to ANSI/AWWA C509 and with the recommendations of the manufacturer.

3.2.07 Double Disc Gate Valves. Valves shall be handled and installed in accordance with the recommendations set forth in the Appendix to AWWA C500 and with the recommendations of the manufacturer.

3.2.08 Air Release and Combination Air Valves. The exhaust from each valve shall be piped to a suitable point acceptable to Engineer. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches (150 mm) above the floor.

3.2.09 Valve Boxes. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3.2.10 Yard Hydrants. A concrete slab 18 inches (450 mm) square and 4 inches (100 mm) thick shall be provided around the top of each 3/4 inch (19 mm) and 1-1/2 inch (38 mm) yard hydrant. Hydrants shall be installed plumb. Hydrant drainage shall be provided by installing below each hydrant at least 1 cubic foot (0.03 m^3) of gravel or crushed stone.

Each 4 inch (100 mm) yard hydrant shall be set on a concrete foundation at least 18 inches (450 mm) square and 6 inches (150 mm) thick. Each hydrant shall be anchored in place or adequately blocked to prevent the hydrant from blowing off the supply connection. Hydrant drainage shall be provided by installing at least 7 cu. ft (0.20 m^3) of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.

An operating wrench shall be provided for each yard hydrant.

3.3 VALVE ACTUATORS. Valve actuators and accessories will be furnished by others and shall be installed in accordance with the equipment manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL.

3.4.01 Field Testing. After installation, all valves 12” and above shall be tested in conjunction with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.4.01.01 Pressure Tests. Pressure testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.4.01.02 Leakage Tests. All valves shall be free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor. Leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.5 ADJUSTING. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic and electric actuated valve.

End of Section

SECTION 15020

MISCELLANEOUS PIPING AND ACCESSORIES INSTALLATION

PART 1 - GENERAL

1.1 SCOPE. This section covers the installation of miscellaneous piping, cast iron soil pipe, copper tubing, and accessories as indicated on the drawings. Contractor shall furnish all necessary jointing materials, coatings, and accessories that are specified herein.

Pipe supports and anchors shall be furnished by Contractor, and are covered in Master Specification Section 15140, Pipe Supports. Pipe trenching and backfilling are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

1.2 GENERAL.

1.2.01 Coordination. Materials installed under this section shall be installed in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by Engineer.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Chlorine tank car unloading connection.

Cleaning procedure for metal chlorine piping.

Watertight/dusttight pipe sleeves.

1.3.02 Welder Certification. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified. Copy of certification and identification stamp shall be submitted for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by Engineer.

1.3.03 Spool Drawings. Spool drawings indicating the complete line, showing all welded and assembly items, except for insulation shoes or nonstress-relieved lines shall be developed and submitted.

1.4 QUALITY ASSURANCE.

1.4.01 Welding and Brazing Qualifications. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.4.02 Tolerances. These tolerances apply to in-line items and connections for other lines.

The general dimension, such as face-to-face, face on end-to-end, face- or end-to center and center-to-center shall be 1/8 inch [3 mm].

The inclination of flange face from true in any direction shall be 3/64 inch per foot [4 mm per meter].

Rotation of flange bolt holes shall not exceed 1/16 inch [1.5 mm].

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Plastic pipe, tubing, and fittings shall be stored between 40°F and 90°F (4°C and 32°C).

1.5.01 Coated Pipe. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic-coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Pipe, tubing, and fittings covered herein shall be installed in the services indicatedin the Contract Documents.

2.2 MATERIALS.

Solder	Solid wire, ASTM B32, Alloy Grade Sb5, (95-5).
Soldering Flux	Paste type, Fed Spec O-F-506, Type I, Form A.
Brazing Filler Metal	AWS A5.8, BCuP-5; Engelhard "Silvaloy 15", Goldsmith "GB-15", or Handy & Harman "Sil-Fos".
Brazing Flux	Paste type, Fed Spec O-F-499, Type B.
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Pipe Insulation	See Section 15250.
Watertight/Dusttight Pipe Sleeves	O-Z Electrical Manufacturing "Thruwall" and "Floor Seals", or Thunderline "Link-Seals"; with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts.
Pipe Sleeve Sealant	Polysulfide or urethane, as specified in the caulking section.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Never-Seez "Pure Nickel Special", or Permatex "Nickel Anti-Seize".
Teflon Thread Sealer	Paste type; Hercules "Real-tuff", John Crane "JC-30", or Permatex "Thread Sealant with Teflon".

Teflon Thread Tape	Hercules "Tape Dope" or John Crane "Thred-Tape".
Solvent Cement	
PVC Systems	ASTM D2564.
CPVC Systems	ASTM F493.
Sodium Hypochlorite, Sodium Hydroxide, and Sodium Bisulfite Service	IPS Corporation "Weld-On 724"
Primer	ASTM F656.
Protective Coatings	
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils [760 μm]; Protecto Wrap "200" or Tapecoat "CT".
Primer	As recommended by the tape manufacturer.
Medium Consistency Coal Tar	Carboline "Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol".
Chlorine Tank Car Unloading Connection	Special flanged hose assembly conforming to materials and details on Drawing No. 135, The Chlorine Institute, Inc.

PART 3 - EXECUTION

3.1 INSPECTION. All piping components shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 PREPARATION.

3.2.01 Field Measurement. Pipe shall be cut to measurements taken at the site, not from the drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION.

3.3.01 General. All instruments and specialty items shall be installed in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and with sufficient clearance and access for ease of operation and maintenance.

Flat faced wrenches and vises shall be used for copper tubing systems. Pipe wrenches and vises with toothed jaws will damage copper materials and shall not be used. Bends in soft temper tubing shall be shaped with bending tools.

3.3.02 Pipe Sleeves. Piping passing through concrete or masonry shall be installed through sleeves that have been installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors with a special finish, such as ceramic or vinyl composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. Unless otherwise indicated on the drawings, in all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch (25 mm) nor more than 2 inches [50 mm] above the floor surface, with the projections uniform within each area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the drawings indicate future installation of pipe, sleeves fitted with suitable plastic caps or plugs shall be provided.

Holes drilled with a suitable rotary drill will be considered instead of sleeves for piping which passes through interior walls and through floors with a special finish.

Unless otherwise indicated on the drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements.

Piping passing through locations shall be made dusttight and gastight with special rubber-gasketed sleeve and joint assemblies; with sleeves sealed with modular rubber sealing elements; or by caulking with oakum and polysulfide or urethane sealant.

3.3.03 Pipe Joints. Pipe joints shall be carefully and neatly made in accordance with the indicated requirements.

3.3.03.01 Threaded. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs.

Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads.

Threaded joints in steel piping for chlorine service shall be made up with teflon thread tape or litharge and glycerine paste applied to all male threads.

Threaded joints for diesel fuel oil and fuel oil piping shall be seal welded.

At the option of Contractor, threaded joints in other piping may be made up with teflon thread tape, thread sealer, or a suitable joint compound.

Seal welds shall cover all exposed threads. Thread tape and joint compound or sealers shall not be used in threaded joints which are to be seal welded. Seal welding of threaded joints that have failed a pressure test shall not be made until all thread compound and teflon tape have been removed.

3.3.03.02 Compression. Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past fingertight, or as recommended by the fitting manufacturer, to produce a leaktight, torque-free connection.

3.3.03.03 Flared. Ends of annealed copper tubing shall be cut square, and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as needed to produce leaktight connections.

3.3.03.04 Soldered and Brazed. Where solder fittings are specified for lines smaller than 2 inches [50 mm], joints may be soldered or brazed at the option of Contractor. Joints in 2 inch [50 mm] and larger copper tubing shall be brazed. Joints in copper chlorine tubing and refrigerant piping shall be brazed; solder will not be acceptable. Brazing alloy shall contain no tin.

Surfaces to be joined shall be thoroughly cleaned with flint paper and coated with a thin film of flux. At each joint, tubing shall enter to the full depth of the fitting socket.

Care shall be taken to avoid overheating the metal or flux. Each joint shall be uniformly heated to the extent that filler metal will melt on contact. While the joint is still hot, surplus filler metal and flux shall be removed with a rag or brush.

3.3.03.05 Solvent Welded. Solvent welded connections shall only be used for PVC or CPVC pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing time, as set forth in Table X2.1 of ASTM D2855, has elapsed.

3.3.03.06 Epoxy and Adhesive Bonded. Epoxy and adhesive bonded joints shall only be used for FRP pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. After joining, either the pipe or the fitting shall be rotated approximately one-half turn to uniformly distribute adhesive. A slight fillet of adhesive at the bond line is desirable, but all excess adhesive shall be wiped off immediately. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the curing period recommended by the manufacturer.

3.3.03.07 Heat Fusion Bonded Joints. All joint preparation, cutting, jointing equipment, and jointing procedures shall comply with the pipe manufacturer's recommendations. The heating time, temperature, pressure applied to the joint during bonding, and cooling time shall consistently produce leaktight joints as strong as the pipe being joined.

3.3.03.08 Flanged. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but shall not be torqued less than the minimum value required by the gasket manufacturer. Flange bolts shall not be so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.

Flange bolt holes shall be oriented as follows, unless otherwise indicated on the spool drawings:

Vertical flange face:	Bolt holes to straddle the vertical centerlines.
Horizontal flange face:	Bolt holes to straddle plant north-south centerlines.

Pipe sealants, thread compounds, or other coatings shall not be applied to flange gaskets unless recommended by the gasket manufacturer for the specified service and approved by Engineer.

Welds at orifice flanges shall have internal surfaces ground smooth to the pipe wall.

Slip-on flanges shall be welded inside and outside. There shall be a distance of approximately 1/16 to 1/8 inch [1.5 to 3 mm] between the edge of the fillet weld and the face of the flange. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.

Flat-faced flanges shall be used when mating to Class 125 flanges. Full-face gaskets shall be used with flat-faced flanges and ring gaskets shall be used with raised faced flanges.

Weld neck flanges shall be used with butt-weld fittings. The bore of weld neck flanges shall match the pipe wall thickness.

Insulating joints connecting submerged (buried) piping to exposed piping shall be installed above the maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged (buried) metallic piping shall be isolated from the concrete reinforcement. Insulating flanges shall be tested for electrical isolation after installation and bolt-up but prior to introduction of conducting fluid.

3.3.03.09 Welded. Welding shall conform to the specifications and recommendations contained in the ANSI B31.1 Code for Pressure Piping.

Weld cross-sections shall be equal to or greater than the pipe wall thickness. Welds shall be smooth and continuous and shall have interior projections no greater than 1/16-inch [1.5 mm]. Backing strips or rings shall not be used except with specific prior review by Engineer as to use, material, and design. Root gap inserts that are completely melted and consumed in the weld bead are acceptable only when reviewed in advance by Engineer.

Stainless steel welding shall be inert gas tungsten arc (TIG) or the direct current, straight polarity, inert gas metal arc process (MIG).

Carbon steel welding shall be made by the shielded metal arc process.

3.3.03.10 Grooved Couplings. Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions, as set forth in AWWA C606, and shall be clean and sharp without burrs or check marks.

3.3.03.11 Push-on. Gasket installation and other jointing procedures shall be in accordance with the recommendations of the manufacturer. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

3.3.03.12 Rubber-Gasketed. Rubber-gasketed joints for hub and spigot type cast iron soil pipe shall have plain spigot ends, without beads. Cut ends of all pipe shall be cut square, beveled, and all burrs shall be removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

3.3.03.13 Other Pipe Joints. Coupled joints in tempered glass pipe, plastic joints in vitrified clay pipe, and other proprietary type joints shall be made in accordance with the manufacturer's recommendations and to the satisfaction of Engineer.

3.3.04 Pipe. Pipe shall be installed as specified, as indicated on the drawings, or, in the absence of detail piping arrangement, in a manner acceptable to Engineer.

Piping shall be installed without springing or forcing the pipe in a manner which would induce stresses in the pipe, valves, or connecting equipment.

Piping shall be supported in conformance with Master Specification Section 15140, Pipe Supports.

Piping shall be connected to equipment by flanges or unions as specified in the pipe procurement sections. Piping connecting to equipment shall be supported by a pipe support and not by the equipment.

Water, gas, and air supply piping shall be provided with a shutoff valve and union at each fixture or unit of equipment, whether or not indicated on the drawings, to permit isolation and disconnection of each item without disturbing the remainder of the system. Air supply piping shall be provided with sectionalizing valves and valved air inlet connections as needed for isolation of portions of the system for periodic testing. Gas supply lines to buildings shall be provided with a shutoff valve and union located above grade immediately outside the building. A capped drip leg shall be provided at the bottom of the vertical riser of gas supply piping adjacent to gas-fired appliances.

A union shall be provided within 2 feet [600 mm] of each threaded-end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping adjacent to devices or equipment which may require removal in the future and where required by the drawings or the specifications.

All air piping shall be graded to points of drainage collection where drip legs and drain valves shall be provided. Air piping shall be sized for the service conditions, with the indicated minimum sizes:

Service	Minimum Size
Air signal	1/4 inch OD [6 mm OD]
Power air	1/2 inch OD [13 mm OD]
Air supply	1/2 inch OD [13 mm OD]
Bubbler drop pipes	3/4 inch [19 mm]
Buried piping	3/4 inch [19 mm]

Water supply piping within structures shall be arranged, and facilities provided, for complete drainage. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.

All digester gas piping shall be graded to points of drainage collection where drip legs and drip traps shall be provided.

Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.

Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a ball type shutoff valve.

Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

In all piping except air and gas piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

Buried PVC piping shall be "snaked" in the trench and shall be kept as cool as possible during installation. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation.

All chemical piping shall be installed so that lines are readily accessible for cleaning. Tees shall be provided at regular intervals in all chemical piping except chlorine piping, with extra openings plugged, to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of the plugs so that they can be easily removed. At each point where hose or reinforced plastic tubing is connected to rigid piping, a quick-disconnect coupling shall be provided.

Anhydrous ammonia, chlorine and sulfur dioxide gas and vent piping shall be installed so that liquid traps are avoided. The open end of each vent line shall elbow down and shall be provided with a corrosion-resistant insect screen.

Double-contained chemical feed piping shall be installed according to the manufacturer's recommendations. Joints shall be solvent cemented. Splitting and rewelding of fittings will not be acceptable. Suitable drains and vents shall be provided to permit complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be designed to allow continuous drainage in the annular space to the drain ports. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment can be readily drained and manually inspected for leaks.

Polyethylene piping shall be installed in accordance with the manufacturer's recommendations. A continuous 12 AWG THHN insulated copper tracer wire shall be placed 6 inches (150 mm) above all portions of the buried pipe, but no more than 18 inches (450 mm) below the ground surface. Where the pipe extends above grade, a 2 foot (0.6 m) length of wire shall be coiled and attached to the pipe.

Piping adjacent to flow sensors shall be installed in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices of the appropriate straight pipe runs both upstream and downstream.

Drains required for operation are shown on the drawings. However, vents at all high points and drains at all low points in the piping that are required for complete draining for pressure test may not be shown on these drawings. Contractor shall add such items as found to be necessary during detail piping design and/or piping installation.

3.3.05 Reducers. Eccentric reducers shall be installed flat on the bottom for steam, condensate return and digester gas services.

3.3.06 Valves. Prior to soldering or brazing valves, teflon and elastomer seats and seals shall be removed to prevent damage.

Isolation valves provided with equipment and instruments shall be located in a manner which will allow ease of access and removal of the items to be isolated.

3.4 PIPING ASSEMBLY.

3.4.01 General. Contractor shall employ only labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner.

Contractor shall designate a quality assurance inspector who is acceptable to the Owner to inspect the installation, cleaning, and testing of the piping systems. The inspector shall also be responsible to maintain records for all spools and appurtenances for inspection and approval by the Owner's designated representative.

The specification and qualification of weld joints and welders shall be in accordance with ASME Boiler Pressure Vessel Code, Section IX, Welding and Brazing.

Weld procedure specifications (WPS) and procedure qualification reports (PQR) shall be submitted to Engineer for review and validation of joint design, efficiencies and strength before fabrication begins.

The supervision of quality control and quality assurance programs for shop-fabricated piping and skid-mounted equipment for both direct and sub-contracted work shall be by Contractor.

Inspection techniques and acceptance criteria shall be in accordance with Section VI, Inspection, Examination, and Testing of the Piping Codes and ASME Boiler and Pressure Vessel Code Section V, Nondestructive Examination.

Contractor shall have a quality control/quality assurance program to do the following minimum level of nondestructive examination (NDE) for steam and condensate systems:

> 100 percent visual examination of welds by a qualified examiner (per B31.1).
>
> 20 percent random sampling for material's compliance with fitting, pipe, valves and flange requirements. Materials are considered acceptable if the examiner can visually identify foundry markings or mill marking and the ASTM markings comply with engineering specifications.
>
> 10 percent of the flanges will be torqued with a calibrated torque wrench. Acceptance criteria for bolt torque will be identified in the QC Program Manual. Bolts and nuts will be checked for foundry markings and compared to the Specifications.
>
> 100 percent of the piping supports that use guides, anchors, spring hangers, and stops will be examined.

Contractor shall have a quality control/quality assurance program to do the following minimum level of nondestructive examination (NDE) for all other systems:

5 percent random sampling of 100 percent radiographic testing (RT) or ultrasonic testing (UT) or in-process visual weld examination.

15 percent random sampling for material's compliance with fitting, pipe, valve and flange requirements. Materials are considered acceptable if the examiner can visually identify the foundry markings or mill marking and the ASTM markings comply with engineering specifications.

10 percent of the flanges will be torqued with a calibrated torque wrench. Bolts and nuts will be checked for foundry markings and compared to the Specifications.

100 percent of the piping supports that use guides, anchors and stops will be examined.

If Contractor has developed alternative techniques or intends to apply alternative methods considered equivalent to those indicated herein, a proposal on such techniques or methods shall be submitted in writing to Engineer for review and approval at least 14 days before intended date of use.

If there is a conflict between the mechanical drawings and piping and instrumentation drawings (P&IDs), the P&ID shall take precedence.

Any deviations from the Specifications and piping locations shown on the Drawings require prior review and approval by Engineer.

Welding shall not begin until weld joint and welder qualification submittals have been reviewed and approved.

3.5 PROTECTIVE COATING. Standard weight black steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating.

Extra strong black steel pipe in buried locations shall have exterior surfaces protected as specified herein.

The exterior surfaces of all fittings, couplings, specials, and other portions of buried piping not protected with plastic coating shall be tape-wrapped in the field. All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils [1.5 mm]. Joints in plastic-coated pipe shall be cleaned, primed, and tape-wrapped after installation.

Joints in galvanized steel piping in underground locations shall be field painted with two coats of coal tar coating.

3.5.01 Inspection. All shop-applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field-applied tape wrap on pipe, joints, fittings, and valves shall be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings after installation of the pipe or fitting in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged during installation. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.

The inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.4 of ANSI/AWWA C209.

3.6 PRESSURE AND LEAKAGE TESTING. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. Piping shall be tested at the indicated pressures:

Service	Test Pressure	Test Medium
Water supply	1-1/2 times working pressure but not less than 120 psi [828 kPa]	Water
Gas supply	1-1/2 times working pressure but not less than 60 psi [414 kPa]	Compressed air
Air supply and signal	1-1/2 times working pressure but not less than 50 psi [345 kPa]	Zero humidity air or nitrogen
Liquid chlorine and anhydrous ammonia, chlorine and sulfur dioxide gas pressure piping	300 psi [2068 kPa]	Zero humidity air or nitrogen
Chlorine and sulfur dioxide gas	15 inches [51 kPa] of mercury vacuum	Atmospheric air

vacuum piping		
Other piping	1-1/2 times working pressure but not less than 50 psi [345 kPa]	Suitable fluid or gas; for distilled water piping, distilled water or filtered oil-free compressed air may be used

Compressed air or pressurized gas shall not be used for testing plastic piping unless specifically recommended by the pipe manufacturer.

Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped as needed during the testing.

After completion of the specified pressure tests, all anhydrous ammonia, chlorine and sulfur dioxide gas piping shall be tested for leakage using the appropriate gas chemical at operating pressures. Piping shall be thoroughly cleaned and dried before admitting gas chemical into the system. Gas chemical shall be slowly admitted to the piping system.

For chlorine gas piping, leakage shall be checked by waving a swab soaked in aqua ammonia solution near each fitting. Ammonia solution shall not be applied directly to the fittings. Formation of white fumes will indicate the presence of leaks. All chlorine gas shall be purged from the line before leaks are repaired.

Unless otherwise required by the applicable codes, drainage and venting systems shall be water or air tested, as required. For water testing, the drainage and venting system shall be filled with water to the level of the highest vent stack. For air testing, the system shall be charged with air to a minimum pressure of 5 psig [35 kPa]. Openings shall be plugged as necessary for either type of test. To be considered free of leaks, the system shall hold the water or air for 30 minutes without any drop in the water level or air pressure.

All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor and at the time directed by Engineer.

All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

3.6 CLEANING. The interior of all pipe, valves, and fittings shall be smooth, clean, and free of blisters, loose mill scale, sand, dirt, and other foreign matter when installed. Before being placed in service, the interior of all lines shall be thoroughly cleaned, to the satisfaction of Engineer.

Metal anhydrous ammonia, chlorine and sulfur dioxide piping shall be cleaned as recommended by the gas chemical feed system supplier. All surfaces which may come into contact with gas chemical shall be thoroughly dry and free of oil or grease before being placed in service. The recommended cleaning procedures shall be submitted for review in accordance with Master Specification Section 01080, Project Submittals.

Tin-lined copper tubing for distribution of distilled water shall be flushed and cleaned with distilled water in accordance with the tubing manufacturer's recommendations.

3.7 ACCEPTANCE. Owner reserves the right to have any section of the piping system which he suspects may be faulty cut out of the system by Contractor for inspection and testing. Should the joint prove to be sound, Owner will reimburse Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test will continue joint by joint in all directions until sound joints are found. Costs for replacement of faulty work and/or materials shall be the responsibility of Contractor.

End of Section

SECTION 15060

MISCELLANEOUS PIPING AND PIPE ASSEMBLIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous piping and pipe assemblies for the services as indicated in the Contract Documents. This section includes the following types of pipe:

Regular Weight Brass Pipe
Extra Strong Brass Pipe
Polyethylene Hose
Tempered Glass Pipe
Nickel Alloy Pipe

Miscellaneous piping shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but shall not be limited to, the following:

Chemical resistant waste pipe and fittings.

Hose couplings.

Name of Manufacturer

Type and model

Construction materials, thickness, and finishes,

Pressure and temperature ratings

1.3 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Miscellaneous piping materials shall be as indicated.

Material Classification	BR-1
Regular Weight Brass Pipe	
Pipe	ASTM B43, red brass, seamless, regular weight.
Fittings	ANSI/ASME B16.15, Class 125.
Material Classification	BR-2
Extra Strong Brass Pipe	
Pipe	ASTM B43, red brass, seamless, extra strong.
Fittings	ANSI/ASME B16.15, Class 125.
Material Classification	HS-1
Hose With Insert Type Couplings	
Hose	ID not smaller than nominal size.
	Boston " Crosslinked Polyethylene Hose" or Gates "Renegade", "Mustang 45 HW" or "Stallion" acid-chemical hose. To be selected for resistance to the service chemical.
Couplings	Rigid PVC or other material suitable for service conditions, with band type stainless steel clamps.
Material Classification	HS-2
Hose With Quick Disconnect Couplings	

Hose	ID not smaller than nominal size. Boston " Crosslinked Polyethylene Hose" or Gates "Renegade", "Mustang 45 HW" or "Stallion" acid-chemical hose. To be selected for resistance to the service chemical.
Couplings	OPW "Quick Coupler" or PT Coupling "Quick Connect/Disconnect Coupling"; polypropylene or other material suitable for service conditions.
Material Classification	TG-1
Tempered Glass Pipe	
Pipe	Borosilicate glass, ASTM C 1053. Schott "Kimax", or equal.
Fittings	Borosilicate glass, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard drainline coupling with compression liner, seal ring, and stainless steel band and bolt. Joints shall be "bead-to-bead" or "bead-to-plain end" type.
Material Classification	CRP-1
Carpenter 20-Cb3	
Welded	ASTM B464 - UNS NO8020.
Seamless	ASTM B729 - UNS NO8020.
Fittings	ASTM B462 - UNS NO8020. The use of flanged fittings shall be limited to equipment connections.

2.1.02 Accessories. Accessories for miscellaneous piping systems shall be as indicated.

Unions For Brass pipe	Fed Spec WW-U-516, Class 125.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15061

DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of ductile iron pipe, except ductile iron pipe used for buried water main service. Ductile iron pipe shall be furnished complete with all fittings, jointing materials, pipe hangers and supports, anchors, blocking, encasement, and other appurtenances.

Piping furnished hereunder shall be complete with all joint gaskets, bolts, and nuts required for installation of any valves and equipment furnished by others for installation under this contract.

Pipe hangers and supports are covered in Master Specification Section 15140, Pipe Supports. Pressure and leakage testing is covered in Master Specification Section 15020, Miscellaneous Piping and Accessories Installation. Cleaning and disinfection are covered in Master Specification Section 02675, Disinfection of Water Distribution System. Cast iron soil pipe is covered in Master Specification Section 15069, Cast Iron Soil Pipe and Accessories.

Ductlie iron pipe for buried water main service is covered in Master Specification Section 02620, Water Main Services and Gate Valves. Pipe trenching, bedding, and backfill are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

1.1.02 Pipe Manufacturer’s Experience and Field Services. All ductile iron pipe, fittings, and specials shall be fabricated, lined, and coated by the pipe manufacturer. Minimum required experience qualifications shall include manufacture of a pipeline at least 1 mile (1.6 km) in length, of equal or larger diameter than the pipe to be provided, with joints, lining, and coating suitable for the same or greater pressure rating, which has performed satisfactorily for the past 5 years.

An experienced, competent, and authorized field service representative shall be provided by the pipe manufacturer to perform all pipe manufacturer’s field services specified herein. The field service representative's minimum required experience qualifications shall include 5 years of practical knowledge and experience installing ductile iron pipe with joints, lining, and coating of the pipe to be provided. The pipe manufacturer’s field service representative shall be acceptable to Owner. A resume of the proposed pipe manufacturer’s field service representative shall be submitted for review. The resume shall include the field service representative’s experience record which meets the specified minimum required experience qualifications.

All ductile iron pipe shall be installed in accordance with the pipe manufacturer's recommendations. The pipe manufacturer's field service representative shall visit the site and inspect, check, instruct, guide, and direct Contractor's procedures for pipe handling, laying, and jointing at the start of pipe installation for each crew. The pipe manufacturer's field service representative shall coordinate his services with Contractor.

Each joint, including restrained joints, shall be checked by Contractor as instructed by the pipe manufacturer's field service representative to determine that the joint and the restraints are installed properly.

The pipe manufacturer's field service representative shall furnish to Owner, through Engineer, a written report certifying that Contractor's installation personnel have been properly instructed and have demonstrated the proper pipe handling and installation procedures. The pipe manufacturer's field service representative shall also furnish to Owner, through Engineer, a written report of each site visit.

All costs for these services shall be included in the Contract Price.

1.1.03 <u>Emergency Repair Manual</u>. Contractor shall submit an emergency repair manual prepared and furnished by the pipe manufacturer. The emergency repair manual shall include procedures for handling emergency calls and repairs; a list of stock replacement pipe sections, closures, and other parts needed for emergency repairs; names and emergency telephone numbers of pipe manufacturer's engineering staff and factory-trained field service representatives who can be contacted day or night during an emergency; response and delivery times; and installation instructions for the materials and methods used in making repairs. The pipe manufacturer shall provide emergency assistance that may be required, during the construction and warranty period, at no additional cost to Owner.

1.2 <u>SUBMITTALS</u>. Drawings, details, specifications, and installation schedules covering all ductile iron pipe and accessories shall be submitted in accordance with the procedure set forth in Master Specification Section 01080, Project Submittals. The drawings and data shall include, but shall not be limited to, the following:

> Certification by manufacturer for each item furnished in accordance with the ANSI/AWWA Standards.
>
> Certification of gaskets.
>
> Certification of proof-of-design tests for joints.
>
> Certification of proof-of-design tests for welded-on outlets.

Laying schedule complete with an explanation of all abbreviations used in the schedule.

Two samples of the polyethylene encasement, each sample clearly indicating all identification required by the Governing Standard.

Submittal data shall clearly indicate the country of origin of pipe, fittings, restraining devices, and accessories. Certified copies of physical and chemical test results as outlined in AWWA C151 shall be submitted for the materials to be provided.

Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining when it is specified.

Contractor furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.

If the lining of Owner furnished pipe or fittings is damaged by Contractor during unloading or handling, the damaged pipe or fittings shall be replaced by and at the expense of Contractor. Where the damaged areas are small and readily accessible, Contractor may be permitted to repair the lining.

Contractor shall repair any damage to pipe coatings before the pipe is installed.

PART 2 - PRODUCTS

2.1 PIPE CLASS. The class of ductile iron pipe shall be as indicated in the Ductile Iron Pipe Schedule 15061-S01 or as indicated in the Contract Documents. The specified class includes corrosion allowance and casting allowance.

Pipe wall thickness for grooved and threaded pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size		Minimum Class	
Inches	mm	Threaded Ends (1)	Grooved Ends (2)
4-16	100-400	53	53
18	450	53	54
20	500	53	55
24	600	53	56
30-54	750-1400	53	--
60 & 64	1500-1600	350	--

(1) Complies with ANSI/AWWA C115/A21.15 for minimum pipe wall thickness for threaded flanges.

(2) Grooved couplings are cataloged through 24 inch (600 mm); larger sizes require cast-on or threaded-on shoulders.

2.2 MATERIALS. All materials in contact with potable water shall have NSF 61 certification.

Pipe	Ductile iron, ANSI/AWWA C151/A21.51, Table 1 or Table 3.
Gaskets – All Joint Types	Gaskets shall be synthetic rubber. Natural rubber will not be acceptable. For potable water service, gaskets shall be certified as suitable for chlorinated and chloraminated potable water; a certificate of gasket suitability shall be submitted.
Fittings	Ductile iron, ANSI/AWWA C110/A21.1 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the drawings.

Fitting Size in (mm)	Material	Type	Min. Working Pressure Rating, psi (kPa)
4 to 24 (100 to 600)	DI	Mechanical and Push-on joints	350 (2400)
4 to 24 (100 to 600)	DI	Flanged joints	250 (1700)
30 to 48 (750 to 1200)	DI	All joints	250 (1700)
54 to 64 (1350 to 1600)	DI	All joints	150 (1000)

All fittings shall be ductile iron and suitable for a test pressure of 1.5 times rated working pressure without leakage or damage.

Push-on Joints	ANSI/AWWA C111/A21.11.
Restrained Push-on Joints, gaskets with stainless steel gripping segments, as required (4 inch through 12 inch) (100 mm through 300 mm).	US.Pipe "Field Lok Gasket", or American "Fast Grip".
Restrained Push-on Joints, locking wedge type, as required (4 inch through 20 inch) (100 mm through 500 mm).	EBAA Iron "Megalug" Series 1700, without exception.
Restrained Push-on Joints, positive locking segments and/or rings, as required (4 inch through 64 inch) (100 mm through 1600 mm).	American "Flex-Ring," or "Lok-Ring"; Clow "Super-Lock"; U.S. Pipe "TR Flex"; or Griffin "Snap-Lok".
Flanged Joints	ANSI/AWWA C115/A21.5.
Flanges	
Class 250	Ductile iron, flat faced, with ANSI/ASME B16.1, Class 250 diameter and drilling.

All Others	Ductile iron, ANSI/AWWA C115/A21.15.
Flanges	All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.
Bolts	ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch (6.3 to 12.7 mm) beyond outer face of nut.
Nuts	ASTM A307, hexagonal, ANSI/ASME B18.2.2, heavy semi-finished pattern.
Gaskets	ASTM D1330, Grade I rubber, full face type, 1/8 inch (3 mm) thick.
Insulated Flanges	
Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.
Insulation Kits	As manufactured by Central Plastics or PSI Industries.
Insulating Gaskets	Type E, pyrox 1E glass reinforced epoxy, 1/8 inch (3 mm) thick, with Buna-N sealing element.
Bolt Insulating Sleeves	Mylar, 1/32 inch (0.79 mm) thick.
Insulating Washers	Phenolic laminate, 1/8 inch (3 mm) thick, one for each flange bolt.
Backing Washers	Steel, 1/8 inch (3 mm) thick, two for each flange bolt.
Mechanical Joints	ANSI/AWWA C111/A21.11.
Restrained Mechanical Joints (Factory prepared spigot), as required (4 inch through 48 inch) (100 mm through 1200 mm).	American "MJ coupled Joints", or Griffin "Mech-Lok".

Restrained Mechanical Joints, (field cut spigot), as required (4 inch through 20 inch) (100 mm through 500 mm).	EBAA Iron "Megalug" Series 1100, without exception.
Wall Castings	Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron. All holes shall be sized in accordance with the details on the drawings and shall be provided with removable plugs.
Mechanical Joints with Tie Rods	See standard details.
Tie Rods	ASTM A307.
Steel Pipe	ASTM A53, standard weight.
Washers	ANSI B18.22.1, plain steel.
Threaded Connections	ANSI/ASME B1.20.1, NPT; provide boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.
Mechanical Couplings	
Couplings	Dresser "Style 38," Smith-Blair "441 or 411 Flexible Coupling," or Romac "Style 501"; without pipe stop.
Gaskets	Oil-resistant synthetic rubber.
Grooved Couplings	AWWA C606.
Pipe Ends (rigid joints), as required.	Grooved, with dimensions conforming to AWWA C606, Table 3.
Pipe Ends (flexible joints), as required	Shouldered, with dimensions conforming to AWWA C606, Table 4.

Couplings (non-shouldered pipe)	Grinnell "Figure 7001," or Victaulic "Style 31."
Couplings (shouldered pipe)	Victaulic "Style 41" or "Style 44".
Flanged Coupling Adapters	Smith-Blair "Type 912" or Romac "Style FCA501", with anchor studs for 12 inches (300 mm) and smaller, as required; Smith-Blair "Type 913" or Romac "Style FC400", 14 inches (350 mm) and larger.
Tapping Saddles	Ductile iron, with steel straps and rubber sealing gasket, 250 psi (1700 kPa)) pressure rating.
Shop Coating and Lining	
Cement Mortar Lining	ANSI/AWWA C104/A21.4.
Polyethylene Lining	ASTM D1248, Class C, heat bonded, 40 mil (1000 μm) nominal thickness, except min thickness shall be at least 30 mils (750 μm). Thickness may taper to not less than 10 mils (250 μm))beginning 4 inches (100 mm) from the end of pipe or fitting.
Ceramic Epoxy Lining	Induron "Protecto 401 Ceramic Epoxy".
Calcium Aluminate Lining	La Farge "SewperCoat".
Glass Lining	Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 8 mils (200 μm), Mohs' Hardness 5 to 6 density (2500 to 3000 kg/m^3) as determined by ASTM D792; Ceramic Coating "Non-Stick Glass Lining" or Victo "SG-14 Glass Lined Pipe."
Universal Primer	Manufacturer's standard.
Asphaltic Coating	Manufacturer's standard.
Coal Tar Epoxy	Manufacturer's standard.

Liquid Epoxy	ANSI/AWWA C210.
Medium Consistency Coal Tar	Carboline "Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol."
Polyethylene Encasement	Seamless, ANSI/AWWA C105/A21.5; LLD-8 mil (200 μm) or HDCL-4 mil (100 μm).

2.3 SHOP COATING AND LINING. The interior of all pipe and fittings for water or water treatment service shall be cement mortar lined. The interior of all pipe for gravity sewers shall be lined with the material as specified herein. The interior of all pipe for other services, except air, shall be cement mortar lined. The interior of all air piping shall be unlined and uncoated.

Glass-lined pipe or other lining, as specified, shall be provided for the following wastewater facilities services:

Scum piping.

All sludge piping except piping conveying activated sludge from final settling basins.

Sludge holding tank overflow piping.

Sludge holding tank supernatant drawoff piping.

Where buried or embedded in concrete, glass-lined pipe shall be ductile iron with mechanical or push-on joints; glass-lined pipe installed in interior locations may be flanged ductile iron with flanged cast or ductile iron fittings.

The exterior surfaces of all pipe and fittings which will be exposed in interior locations shall be shop primed. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

PART 3 - EXECUTION

3.1 INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; spigot ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site of the work.

3.2 PREPARATION. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter prior to installation. Before jointing, all joint contact surfaces shall be wire brushed if necessary, wiped clean, and kept clean until jointing is completed.

Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

3.3 CUTTING PIPE. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

All field cutting of existing gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.

Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be permitted. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be permitted.

3.4 ALIGNMENT. Piping shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Deflections form a straight line or grade shall not exceed the values stipulated in Table 4 or Table 5 of AWWA C600, unless specially designed bells and spigots are provided.

Either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the drawings.

Batter boards, laser beam equipment, or surveying instruments shall be used to maintain alignment and grade.

If batter boards are used to determine and check pipe subgrades, they shall be erected at intervals of not more than 25 feet (8 m). At least three batter boards shall always be maintained in proper position when trench grading is in progress.

If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.5 LAYING PIPE. Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions.

Whenever pipe laying is stopped, the open end of the pipe shall be sealed with a watertight plug, which will prevent trench water from entering the pipe.

Pipe shall be laid with the bell ends facing the direction of laying, except when reverse laying is specifically authorized by Engineer.

3.6 FIELD JOINTS. Joints in buried locations shall be mechanical or push-on type unless otherwise indicated on the drawings. Bells on wall castings and wall sleeves shall be mechanical joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the drawings.

Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11-90, Section 4.5, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2 times the working pressure or 1-1/2 times the test pressure of the pipeline, whichever is higher. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design.

Where acceptable to Engineer, as required, grooved couplings may be used instead of flanges, provided that rigid grooving is used to preclude longitudinal pipe movement and angular deflection at joints. Fittings, valves, and equipment installed using grooved couplings shall be adequately supported and blocked or restrained to prevent rotation.

3.7 MECHANICAL JOINTS. Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Overtightening of bolts to compensate for poor installation practice will not be permitted.

The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top (or side for vertical piping) center line. The top (or side) center line shall be marked on each flange and mechanical joint piece at the foundry.

3.8 PUSH-ON JOINTS. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

3.9 FLANGED JOINTS. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe center line.

When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually and at a uniform rate, to ensure uniform compression of the gasket.

Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before any bolts are installed in the flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position, which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.

3.10 FLANGED COUPLING ADAPTERS. Flanged coupling adapters shall be installed in strict accordance with the coupling manufacturer's recommendations. After the pipe is in place and bolted tight, the proper locations of holes for the anchor studs shall be determined and the pipe shall be field-drilled. Holes for anchor studs shall be drilled completely through the pipe wall. Hole diameter shall be not more than 1/8 inch (3 mm) larger than the diameter of the stud projection.

The inner surfaces of couplings shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except flange mating surfaces, shall be cleaned and shop primed with universal primer.

3.11 MECHANICAL COUPLINGS. Mechanical couplings shall be carefully installed in accordance with the manufacturer's recommendations. A space of at least 1/4 inch (6 mm), but not more than 1 inch (25 mm), shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

The interior surfaces of the middle rings shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining components shall be cleaned and shop primed with universal primer.

3.12 GROOVED END JOINTS. Grooved couplings with rigid type grooving shall be installed in accordance with the coupling manufacturer's recommendations. Completed joints shall be rigid and shall not allow angular deflection or longitudinal movement. Except for closure pieces, field grooving of pipe will not be permitted.

Special care shall be taken when connecting to pumping equipment to avoid transmitting pipe stresses to the pump flanges. Piping shall be permanently supported to obtain accurate matching of piping and abutting pump flanges before bolts are installed in the flanges.

3.13 POLYETHYLENE ENCASEMENT. All buried ductile iron pipe, including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, and all valves shall be provided with a minimum of one wrap of polyethylene encasement. Locations where ductile iron pipe shall be double wrapped with polyethylene encasement are indicated in the Contract Documents.

Polyethylene tube protection shall be installed in accordance with AWWA C105, Method A. Preparation of the pipe shall include, but is not limited to, removing lumps of clay, mud, cinders, etc., prior to installation.

Where ductile iron pipe is also embedded or encased in concrete, the polyethylene tube shall be installed over the pipe for 5 feet (1.5 m) either side of each end of the concrete encasement.

The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.

3.14 OUTLETS. Where a 12 inch (300 mm) or smaller branch outlet is indicated and the diameter of the line pipe is at least twice the diameter of the branch, a tee, a factory welded-on boss, or a tapping saddle will be acceptable.

Where a 4 inch (100 mm) or larger branch outlet is indicated on the drawings and the diameter of the branch pipe for a given diameter of parent pipe is less than equal to the maximum diameter listed herein, a factory welded-on outlet fabricated from centrifugally cast ductile iron pipe will be acceptable.

Parent Pipe Diameter Versus Maximum Branch Pipe
Diameter for Welded-On Outlets

Parent Pipe Dia inches (mm)	Max Branch Pipe Dia inches (mm)	Parent Pipe Dia inches (mm)	Max Branch Pipe Dia inches (mm)
8 ((200))	4 ((100))	30 ((750))	20 ((500))
10 ((250))	6 ((150))	36 ((900))	24 ((600))
12 ((300))	8 (200))	42 (1050))	30 (750))
14 ((350))	8 ((200))	48 (1200))	30 (750))
16 ((400))	10 ((250))	54 ((1350))	30 ((750))
18 ((450))	12 ((300))	60 ((1500))	30 ((750))
20 ((500))	14 ((350))	64 ((1600))	30 ((750))
24 ((600))	16 ((400))		

All welded-on outlets shall be rated for a working pressure of 250 psi (1700 kPa))and shall have a minimum factor of safety of 2.0. The pipe manufacturer shall provide test data and certification of proof of design. It is not necessary that these tests be performed on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design. Welded-on outlets may be provided as a radial (tee)

outlet, a tangential outlet, or a lateral outlet fabricated at a specific angle to the parent pipe (in 15° (0.262 rad)) increments between
45° and 90° (0.785 to 1.570 rad)) from the axis of the parent pipe), as indicated on the drawings. The fillet weld dimensions for welded-on outlets shall be as specified herein. Parent pipe and branch pipe shall meet hydrostatic test requirements in accordance with AWWA C151, Sec. 51-9, prior to fabrication.

Welded-on Outlet Fillet Weld Dimensions for Specified Outlet Configurations

Radial and Lateral Outlets			Tangential Outlets		
Parent Pipe Dia inches (mm)	Branch Pipe Dia inches (mm)	Weld Fillet Size inches (mm)	Parent Pipe Dia inches (mm)	Branch Pipe Dia inches (mm)	Weld Fillet Size inches (mm)
24 (600) and smaller	24 (600) and smaller	1 x 1 (25 x 25)	8-30 (200-750)	24 (600) and smaller	1-1/4 x 1-1/4 (32 x 32)
30-48 (750-1200)	24 (600) and smaller	1-1/4 x 1-1/4 (32 x 32)	36-54 (900-1350)	24 (600) and smaller	1-1/2 x 1-1/2 (38 x 38)
54-64 (1350-1600)	24 (600) and smaller	2-1/4 x 2-1/2 (57 x 64)	60-64 (1500-1600)	24 (600) and smaller	2-1/2 x 2-1/2 (64 x 64)
42-54 (1050-1350)	30 (750)	2-1/2 x 2-1/2 (64 x 64)	42-54 (1050-1350)	30 (750)	2-1/2 x 2-1/2 (64 x 64)
60-64 (1500-1600)	30 (750)	2-3/4 x 2-3/4 (70 x 70)	60-64 (1500-1600)	30 (750)	2-3/4 x 2-3/4 (70 x 70)

All joints on welded-on branch outlets shall be made in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15, as applicable. All outlets shall be fabricated from centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured and tested in accordance with ANSI/AWWA C151/A21.51. Ni-Rod FC 55® electrodes manufactured by International Nickel Corporation (or an electrode with equivalent properties) shall be used in the manufacture of the fillet welds. Carbon steel electrodes will not be acceptable. Special Thickness Class 53 pipe shall be used for all branch pipe and parent pipe in 4 to 54 inch (100 to 1400 mm) sizes. Pressure Class 350 pipe shall be used for 60 inch and 64 inch (1500 and 1600 mm) parent pipe. After welding, each fabricated outlet shall be subjected to a 15 psi (100 kPa) air test. A soap and water solution shall be applied during the testing procedure to inspect the weld for leakage. Any welds that show air seepage shall be refabricated and retested.

Welded-on outlets shall be fabricated by the pipe manufacturer at its production facilities. Manufacturers of welded-on outlets shall have at least 5 years of satisfactory experience in the manufacture and performance of these products. The manufacturer shall have a documented welding quality assurance system and shall maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall also maintain appropriate welding procedure specifications (WPS), procedure qualification (PQR), and welder performance qualification test (WPQR) records.

The type of pipe end for the branch outlet shall be as specified or indicated on the drawings. The maximum size and laying length of the welded-on branch outlet shall be as recommended by the pipe manufacturer and shall be acceptable to Engineer for the field conditions and the connecting pipe or valve. Pipe embedment material and trench backfill shall be placed and compacted under and around each side of the outlet to hold the pipe in proper position and alignment during the subsequent pipe jointing, embedment, and backfilling.

At locations acceptable to Engineer, drilling and tapping of the pipe wall for 2 inch (50 mm) and smaller pipe connections will also be acceptable, provided that the wall thickness, minus the casting allowance, at the point of connection equals or exceeds the wall thickness required for 4-thread engagement in accordance with Table A.1, Appendix A of ANSI/AWWA C151/A21.51.

3.15 WALL CASTINGS. Wall castings shall be provided where ductile iron pipes pass through concrete walls, unless otherwise indicated on the drawings.

Where a flange and mechanical joint piece is to connect to a mechanical joint wall casting, the bolt holes in the bell of the wall casting shall straddle the top (or the side for vertical piping) center line of the casting and shall align with the bolt holes in the flange and mechanical joint piece. The top center line shall be marked on the wall casting at the foundry.

3.16 REDUCERS. Reducers shall be eccentric or concentric as indicated on the drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

3.17 CONNECTIONS WITH EXISTING PIPING. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, a 200 mg/L chlorine solution.

3.18 INSULATED FLANGED JOINTS. Insulated flanged joints shall be installed where indicated on the drawings. In addition to one full-faced insulated gasket, each flange insulating assembly shall consist of one full-length sleeve, one insulating washer, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch (3 mm) less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the manufacturer.

3.19 CONCRETE ENCASEMENT. Concrete encasement shall be installed where indicated on the drawings. A pipe joint shall be provided within 12 inches (300 mm) of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in Master Specification Section 03300, Cast-In-Place Concrete and Master Specification Section 03200, Concrete Reinforcement. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.20 REACTION ANCHORAGE AND BLOCKING. Concrete blocking shall be installed where indicated on the drawings and shall extend from the fitting to solid, undisturbed earth and shall be installed so that all joints are accessible for repair. The dimensions of concrete reaction blocking shall be as indicated on the drawings. If adequate support against undisturbed ground cannot be obtained, restrained joints shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, restrained joints shall be furnished and installed by and at the expense of Contractor.

Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as required and as indicated on the drawings.

Coatings for appurtenances listed below shall be in accordance with Master Specification Section 09900, Painting, or in accordance with the following paragraph as indicated in the Contract Documents.

All ferrous metal clamps, rods, bolts, and other components of tapping saddles, reaction anchorages, or joint harness, subject to submergence or contact with earth or other fill material and not encased in concrete, shall be protected from corrosion by two coats of medium consistency coal tar applied in the field to clean, dry metal surfaces. The first coat shall be dry and hard before the second coat is applied.

Metal surfaces exposed above grade or within structures shall be given one prime coat and two finish coats of a coating acceptable to Engineer.

3.21 LEAKAGE AND PRESSURE TESTS. Pipe and fittings shall be subjected to a leakage test and a pressure test, as specified herein.

3.21.01 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

Contractor shall provide all necessary pumping equipment; piping connections between the piping and the nearest available source of test water; pressure gauges; and other equipment, materials, and facilities necessary for the tests.

All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping shall be retested by and at the expense of Contractor.

3.21.02 Visual Leakage Inspection. When a leakage test is not conducted, all joints shall be watertight and free from visible leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.22 CLEANING. The interior of all pipe and fittings shall be kept clean of any foreign matter until the work has been accepted.

3.23 SCHEDULE. See Ductile Iron Pipe Schedule 15061-S01.

End of Section

SECTION 15062

STEEL PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of steel pipe 6 inches (150 mm) in diameter and larger, together with fittings, specials, and appurtenances primarily to be used for plant applications. For steel watermain transmission piping, consult Master Specification Section 02626.

Steel pipe smaller than 6 inches (150 mm) in diameter, light wall steel pipe, miscellaneous small piping, pipe supports, concurrent cathodic protection, pressure and leakage tests, and cleaning and disinfection are covered in other sections.

Pipe trenching, bedding, and backfill are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

The size, service, and locations of steel pipelines, and the pipe material alternatives are as indicated in the Contract Documents, or in the Steel Pipe Schedule 15062-S01.

Steel piping shall be furnished and installed complete with all fittings, specials, jointing materials, appurtenances, and accessories indicated on the drawings or otherwise required for proper installation and functioning of the piping.

Piping furnished hereunder shall be complete with all jointing materials required for installation of any valves and equipment furnished by others for installation under this contract.

1.2 GOVERNING STANDARDS. Except as modified or supplemented herein, all steel pipe, fittings, and specials shall conform to the applicable requirements of the following standards:

ANSI/AWWA Standards	Title
C200	Steel Water Pipe 6 Inches (150 mm) and Larger
C203	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied

C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch and Larger - Shop Applied
C206	Field Welding of Steel Water Pipe
C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches Through 144 Inches (100 mm through 3600 mm)
C208	Dimensions for Steel Water Pipe Fittings.
C209	Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
C602	Cement-Mortar Lining of Water Pipelines in Place
C606	Grooved and Shouldered Type Joints

ANSI Standard

B18.2.1	Square and Hex Bolts and Screws

ANSI/ASME Standards

B1.1	Unified Inch Screw Threads
B18.2.2	Square and Hex Nuts
B36.10	Welded and Seamless Wrought Steel Pipe

1.3 SUBMITTALS. Drawings, specifications, installation schedules, welding procedures and welder qualifications, and other data showing complete details of the fabrication, construction, weld locations, joint details and certification, and installation of pipe, fittings, specials, and connections, together with complete data covering all materials proposed for use, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Submittals shall indicate the ASTM designation for the material from which each class of pipe is fabricated.

In addition to the markings, as specified under the governing standard, Contractor's drawings shall include a complete laying schedule with piece description to show where each numbered pipe, fitting, or special is to be installed. The numbers indicated on the drawings shall correspond with those painted on the pipe.

If the flange gasket materials to be provided are other than those specified herein, Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the flanged joints specified herein and are suitable for the specified field test pressure.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Pipe, fittings, specials, and appurtenances shall at all times be handled and stored in a manner that will ensure installation in sound, undamaged condition.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN. Steel pipe, fittings, and specials may be either fabricated or mill type. In either case, all items shall be fabricated to the sizes, dimensions, and shapes indicated on the drawings or specified herein.

The specified size of fabricated pipe, fittings, and specials shall be the nominal inside diameter, in inches (mm), where 12 inches (300 mm) and smaller, and the actual inside diameter of pipe lining or the outside diameter, as specified herein, where 14 inches (350 mm) and larger. Where stab joint pipe is permitted and two or more wall thicknesses are required for pipe of the same size, pipe size may be adjusted slightly to allow the different classes of pipe to be stabbed together.

The specified size of mill pipe, fittings, and specials shall be the nominal pipe size as set forth in ANSI/ASME B36.10.

Pipe design shall be performed by Engineer or the pipe fabricator, as specified herein.

In addition to the pipe markings required by ANSI/AWWA C200, each pipe section, fitting, and special shall be clearly marked to indicate the service, wall thickness, or minimum yield strength of the pipe material.

2.1.01 Pipe Wall Thickness. When pipe design is by Engineer, the minimum wall thickness shall be as indicated in the Steel Pipe Schedule 15062-S01.

When the fabricator is required to design the pipe, the wall thickness shall be determined by the following formula, except that the minimum wall thickness and the maximum diameter to thickness ratio shall be as indicated in the Steel Pipe Schedule 15062-S01. Pipe shall be designed for all conditions indicated in the Steel Pipe Schedule 15062-S01.

$$t = (PD)/(2s),$$

where

t = the pipe wall thickness in inches (mm).

s = the allowable fiber stress in psi, (Pa) which shall not exceed 50 percent of the yield strength of the steel plate at working pressure or 75 percent of the yield strength at shop test pressure.

P = the pipe working pressure or shop test pressure in psi (Pa).

D = the pipe outside diameter, in inches (mm), or straight pipe sections or the larger outside diameter or tapered sections.

2.1.02 Fitting Dimensions. The dimensions of steel pipe fittings shall conform to ANSI/AWWA C208, as specified herein.

2.1.03 Reinforcement of Fittings and Specials. All bends, fittings, branch connections, reducers, and special sections shall be reinforced, or the pipe wall thickness shall be increased, so that the combined stresses due to internal pressure (circumferential and longitudinal) and bending will not exceed 67 percent of the yield strength of the pipe material.

Whether or not indicated on the drawings, reinforcements or additional wall thickness shall be provided as necessary to ensure that the combined stresses do not exceed the specified maximum. Unless otherwise indicated or directed, the internal pressure shall be the specified shop or field test pressure as indicated in the Steel Pipe Schedule 15062-S01 for the piping adjacent to the item in question, and the external load as indicated in the Steel Pipe Schedule 15062-S01 shall be equal to the pipe full of water.

In addition to the above and where in trench, the design of reinforcement or wall thickness shall take into consideration an external load as indicated in the Steel Pipe Schedule 15062-S01.

Wall thicknesses of reducing sections shall be not less than the required thicknesses for the larger ends.

2.1.04 Joints. Acceptable joints of the type indicated on the drawings and as specified herein shall be provided for all pipe installations in the locations indicated or accepted by Engineer. To facilitate installation, additional field-welded or mechanically coupled joints may be provided, but shall be kept to a minimum, and their locations shall be acceptable to Engineer. Field-welded joints shall not be used in pipe smaller than 27 inches (675 mm), except in locations where the interior coating can be satisfactorily repaired and inspected.

2.2 MATERIALS.

Pipe, Fittings, and Specials	ANSI/AWWA C200. All steel shall be fully killed and made to a fine austenitic grain size practice.
Flanged Joints	
Flanges	ANSI/AWWA C207, slip-on, except where otherwise permitted or required.
Dimensions and Drilling	ANSI/AWWA C207, as indicated on the drawings.
Blind Flanges	ANSI/AWWA C207, unless otherwise indicated on the drawings or specified.
Gaskets	ANSI/AWWA C207, full face type, John Crane "Style 999" neoprene, 1/8 inch (3 mm) thick, for field test pressures up to 250 psi (1700 kPa); ring type, John Crane "Style 4160" compressed aramid fiber sheet, 1/16 inch (1.5 mm) thick, for field test pressures above 250 psi (1700 kPa). The products of other manufacturers and other products of the manufacturer named herein will not be acceptable unless a certificate of product suitability is submitted as set forth in the Submittals paragraph herein.

Insulated Flanges

Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.
Insulation Kits	As manufactured by Central Plastics or PSI Industries.
Insulating Gaskets	Type E, pyrox 1E glass reinforced epoxy, 1/8 inch (3 mm) thick, with Buna-N sealing element.
Bolt Insulating Sleeves	Mylar, 1/32 inch (0.7 mm) thick.
Insulating Washers	Phenolic laminate, 1/8 inch (3 mm)thick, one for each flange bolt.
Backing Washers	Steel, 1/8 inch (3 mm) thick, two for each flange bolt.

Flange Bolting

Material	ANSI/AWWA C207.
Type	Bolt and nut; bolt-stud and two nuts permitted for 1 inch (25 mm) and larger.
Bolts and Bolt-Studs	
Length	Such that ends project 1/4 to 1/2 inch (6 to 12.7 mm) beyond surface of nuts.
Ends	Chamfered or rounded.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2A fit. Bolt-studs may be threaded full length.
Bolt Head Dimensions	ANSI B18.2.1; regular pattern for square, heavy pattern for hexagonal.
Nuts	Hexagonal.
Dimensions	ANSI/ASME B18.2.2, heavy,

	semifinished pattern.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2B fit.
Stab Joints	Bell-and-spigot, with rubber gasket as sole element depended upon for watertightness.
Bells and Spigots	Rolled groove, Carnegie shape, or fabricated type, as needed or permitted.
Rubber Gaskets	Continuous O-ring; ANSI/AWWA C200, Section 3.6, except basic polymer shall be synthetic rubber. Natural rubber will not be acceptable.
Mechanical Couplings	
Insulating	Baker "Series 216", Dresser "Style 39", or Smith-Blair "416"; without pipe stop.
Reducing	Baker "Series 220", Dresser "Style 62", or Smith-Blair "413" and "415"; without pipe stop.
All Others	Baker "Series 200", Dresser "Style 38", or Smith-Blair "411 Flexible Coupling"; without pipe stop.
Restrained Joints	Of the type indicated on the drawings or as specified herein.
Lugs or Collars	ASTM A283, Grade B or C; or ASTM A36.
Tie Bolts	ASTM A193, Grade B7.
Threading	ANSI/ASME B1.1, Class 2A fit, coarse thread series for 7/8 inch (22 mm) and smaller, and 8-thread series for 1 inch (25 mm) and larger.
Ends	Chamfered or rounded.
Nuts	Hexagonal, ASTM A194, Grade 2H or better.

Threading	As specified for tie bolts, except Class 2B fit.
Dimensions	ANSI/ASME B18.2.2, heavy semifinished pattern.
Flat Washers	Hardened steel, ASTM A325.
Flanged Coupling Adapters	Dresser "Style 128" or Smith-Blair "913"; with anchor studs of sufficient size and number to withstand test pressure.
Grooved Couplings (when joint movement and deflection is not acceptable)	ANSI/AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
Grooved Couplings (when joint movement and deflection is acceptable)	ANSI/AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 22" or "Style 77", as needed.
Small Branch Connections	
Pipe Nipples	Seamless black steel pipe, ASTM A53, standard weight (Schedule 40).
Welding Fittings	
Threaded Outlets	Bonney "Thredolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Welded Outlets	Bonney "Weldolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Coatings and Linings	
Coal Tar Enamel	ANSI/AWWA C203.
Liquid Epoxy	ANSI/AWWA C210.
Tape Coating	ANSI/AWWA C209 and C214.
Cement Mortar	ANSI/AWWA C205 and C602.
Cement	ASTM C150, Type II.
Sand	ANSI/AWWA C205, Section 4.2.3,

	except sand for field-applied lining shall pass a No. 16 (1.18 mm) sieve.
Epoxy Bonding Agent	ASTM C881, Type II, moisture insensitive and suitable for service conditions.
Latex Admixture	Euclid "Euco Flex-Con" or Sika "SikaLatex".
Medium Consistency Coal Tar	Carboline "Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol".
Bituminous Filler for Wall Fittings	Plastic asphalt roof cement, asbestos-free, ASTM D4586, Type II.
Watertight Pipe Sleeves	Thunderline Corporation "Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts and nuts.
Anchor Bolts	ASTM A307.

2.3 ENDS OF SECTIONS.

2.3.01 For Field Welding. Ends of pipe, fittings, and specials for joints butt-welded in the field shall have the ends beveled for butt welding in accordance with the governing standards.

Ends of pipe, fittings, and specials for field-welded lap joints shall have both the bell and the spigot expanded by pressing (not rolling) to obtain the required shape and welding tolerances.

2.3.02 For Fitting with Flanges. Ends to be fitted with slip-on flanges shall be prepared to accommodate the flanges in accordance with the governing standards.

2.3.03 For Stab Joints. Stab joints shall be designed so that the gasket will maintain a watertight joint under all conditions of service, including expansion, contraction, and earth settlement. The gasket shall not support the entire weight of the pipe. Spigot ends shall have a groove to retain the gasket. Pipe ends shall be self-centering without the aid of the gasket.

2.3.04 For Mechanical Couplings. Ends to be joined by mechanical couplings shall be plain end type in accordance with the governing standard. In addition, pipe seam welds on ends to be joined by mechanical couplings shall be ground flush to permit slipping the coupling in at least one direction to clear the pipe joint.

2.3.05 For Grooved Couplings. Ends to be joined by grooved couplings shall be of the cut grooved or shouldered type as specified herein, conforming to the governing standard and as recommended by the coupling manufacturer for the size and wall thickness of the pipe, fitting, or special being coupled, and for the maximum test or working pressure to which the couplings will be subjected.

2.3.06 For Flanged Coupling Adapters. Ends to be fitted with flanged coupling adapters shall be plain end type in accordance with the governing standard for mechanical couplings. Welds shall be ground flush to permit installation of the coupling, and holes shall be field drilled at the proper location for anchor studs.

2.3.07 For Connection to Dissimilar Pipe Materials. Steel pipe connections to buried or submerged concrete pipe or cast iron pipe shall be made with insulated flanges.

2.4 SEAMS. Except for seamless mill-type pipe, all piping shall be made from steel plates rolled into cylinders or sections thereof with the longitudinal seams butt-welded, or shall be spirally formed and butt-welded. There shall be not more than two longitudinal seams. Girth seams shall be butt-welded and shall be spaced not closer than 10 feet (3 m) apart except in specials and fittings.

2.5 PIPE LENGTHS. Straight pipe section lengths shall be as specified herein, unless otherwise indicated on the drawings.

All pipe to be connected with mechanical couplings shall be fabricated so that the space between pipe ends within the couplings will not exceed the amount recommended by the coupling manufacturer, but will be at least 1/2 inch (12 mm).

2.6 SMALL BRANCH CONNECTIONS. Branch connections 2-1/2 inches (63 mm) and smaller shall be made with welding fittings with threaded outlets. Where the exact outlet size desired is in doubt, but is known to be less than 1 inch (25 mm), a 1 inch (25 mm) outlet shall be provided and reducing bushings used as needed.

Branch connections sized 3 through 12 inches (75 through 300 mm) shall be made with pipe nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as needed to meet design and testing requirements.

Small branch connections shall be so located that they will not interfere with joints, supports, or other details, and shall be provided with caps or plugs to protect the threads during shipping and handling.

2.7 ACCESS MANHOLES. Access manholes shall be provided in the locations indicated on the drawings. The type of manholes shall also be indicated on the drawings. An access manhole marker post shall be furnished and installed adjacent to each buried access manhole as indicated on the drawings.

2.7.01 Type I Manhole. A Type I manhole shall consist of a 24 inch (600 mm) flanged outlet with a blind flange cover. Covers shall be fabricated from steel plate with thickness as indicated on the drawings, and shall have two handles fabricated from 1 inch (25 mm) diameter rod.

At the option of Contractor and subject to acceptance by Engineer, reinforced or dished covers of lighter weight and equal strength may be provided.

2.7.02 Type 2 Manhole. A Type 2 manhole shall be bolted or hinged type, conforming to Figure 13-26 of AWWA M11 and shall be suitable for a pressure as indicated on the drawings.

Covers. Manhole covers shall be fabricated from steel plate with thickness as indicated on the drawings.

Reinforcing Pads. Reinforcing pads shall be provided as indicated on the drawings.

2.7.03 Type 3 Manholes. A Type 3 manhole shall provide an elliptical clear opening at least 14 by 18 inches (350 by 450 mm) and shall be of self-sealing construction, with two steel yokes and a lifting handle on the cover. Each cover shall be hinged from the outside and designed to swing in. The manholes shall withstand, without leaking, the test pressure specified for the pipe in which they are to be installed. The design shall be in accordance with the ASME Code for Unfired Pressure Vessels. Access manholes shall be designed and installed so that flow in the pipe is not obstructed.

2.8 DRAINS AND VENTS. Drains and vents shall be provided at the locations and in the sizes indicated on the drawings. Pipe used for drain and vent piping shall be ASTM A53 standard weight, black steel pipe. Drain valves shall be hose valves. Vent valves shall be resilient seat globe valves. Drain and vent valves shall comply with the requirements of Master Specification Section 15100, Miscellaneous Valves.

2.9 FLANGED JOINTS. Flange faces of flanged joints shall be normal to the pipe axis. Angular deflection (layback) of the flange faces shall not exceed the allowable set forth in Section 4.3 of ANSI/AWWA C207. All flanges shall be refaced after welding to the pipe, if necessary to prevent distortion of connecting valve bodies from excessive flange bolt tightening and to prevent leakage at the joint.

Pipe lengths and dimensions and drillings of flanges shall be coordinated with the lengths and flanges for valves, pumps, and other equipment to be installed in the piping. All mating flanges shall have the same diameter and drilling and shall be suitable for the pressures to which they will be subjected.

Flanges shall be of the slip-on type, except that welding-neck or slip-on flanges welded to short lengths of pipe shall be used where installation of flanges in the field is permitted or required.

2.10 STAB JOINTS. Rubber-gasketed bell-and-spigot (stab type) steel pipe shall be furnished where indicated or specified. The design of the rubber-gasketed bell-and-spigot joints shall be subject to review and acceptance by Engineer.

The difference in circumferential measurements between the outside of the spigot end and the inside of the bell shall be not more than 0.12 inch (3 mm). For pipe with a wall thickness greater than 11/32 inch (8.7 mm), and for 60 inch (1500 mm) and larger pipe, a bar type fabricated spigot shall be furnished. Bends in the pipe wall forming each bell shall have a radius of at least 15 times the pipe wall thickness.

Contractor shall obtain from the fabricator and shall submit certification that the pipe joints will withstand working pressures and test pressures equal to those specified, and documentation that joints of the type proposed have performed satisfactorily under similar conditions.

2.11 MECHANICAL COUPLINGS. The middle ring of mechanical couplings shall have a thickness at least equal to the wall thickness specified herein for the size of pipe on which the coupling is to be used. If the manufacturer's standard thickness is less, that thickness may be used unless allowable pressures are exceeded. The length of each middle ring shall be not less than 10 inches (250 mm) for 36 inch (900 mm) and larger pipe and not less than 7 inches (175 mm) for pipe smaller than 36 inches (900 mm).

When required, the middle rings shall be shop galvanized and the remaining components shall be cleaned and shop primed with 2 mils (50 μm) of a universal primer.

When required, middle rings shall be prepared for coating in accordance with the coating manufacturer's instructions and shall then be coated with 5 mils (125 μm) of liquid epoxy in accordance with ANSI/AWWA C210. The remaining components shall be cleaned and shop primed with 2 mils (50 μm) of a universal type primer.

2.12 GROOVED COUPLINGS. Grooved couplings shall be provided where indicated on the drawings and shall be sized for proper installation on the pipe ends provided. The couplings shall have movement and deflection requirements as needed.

After fabrication, all housing clamps forming the coupling shall be cleaned and primed (as specified for the pipe) by the coupling manufacturer.

2.13 RESTRAINED JOINTS. Restrained joints shall be shall be flanged, welded, flanged coupling adapters with anchor studs, or harnessed, as required, and as specified or indicated on the drawings.

Where indicated on the drawings, mechanically coupled, grooved coupling, or stab type joints shall be restrained with harness bolts and lugs or collars. Joint harnesses shall conform to the details indicated on the drawings. Lugs or collars shall be shop welded to the pipe and coated as specified for the adjacent pipe.

2.14 PROTECTIVE COATINGS AND LININGS. All steel pipe, fittings, specials, wall fittings, and accessories shall be lined, coated, or wrapped as specified herein.

2.14.01 Type of Coating and Lining. Surface preparation shall be in accordance with the coating or lining manufacturer's instructions. Types of protective coating and lining shall be as follows:

Exterior Surfaces in Interior Locations	Shop-applied universal primer. Field painting is covered in Master Specification Section 09900,Painting.
Exterior Surfaces Underground, Including those Encased in Concrete	Coal tar enamel, ANSI/AWWA C203, cement mortar, ANSI/AWWA C205, liquid epoxy, ANSI/AWWA C210, or tape coating, ANSI/AWWA C214, as specified herein. The governing standards shall be as modified herein.
Exterior Surfaces in Contact with Potable Water or Submerged in Water Treatment Process Waters	Cement mortar, ANSI/AWWA C205, or liquid epoxy, ANSI/AWWA C210, as specified herein.
Interior Surfaces	Coal tar enamel, ANSI/AWWA C203, cement mortar - shop applied, ANSI/AWWA C205, liquid epoxy, ANSI/AWWA C210, or cement mortar - field applied, ANSI/ AWWA C602, as specified herein. The governing standards shall be as modified herein.
Pipe Joints	

Couplings	Shop coating as specified for each type of coupling. Field coating as specified for ends of sections.
Ends of Sections	As specified herein.
Machined Surfaces	Rust-preventive compound.

2.14.02 Modifications to the Governing Standards.

2.14.02.01 Coal Tar Enamel Coating. Except as modified or supplemented herein, all materials and their application shall be in accordance with ANSI/AWWA C203, and the appendix thereto when specified herein.

Exterior surfaces of all steel pipe, fittings, and specials which are to be installed underground or which are to be encased in concrete shall be blast cleaned, primed, and coated in the shop with hot-applied coal tar enamel followed by a single layer of outerwrap consisting of glass-fiber felt, polyethylene-kraft paper, or polyethylene-elastomer laminate. The outerwrap shall be coated with shop-applied whitewash or a single layer of kraft paper.

The application of coal tar enamel coating materials, including the preparation of surfaces; priming; and lining and coating of the pipe, fittings, and specials, shall be done in the shop by an established pipe lining and coating company acceptable to the manufacturer of the coal tar enamel materials and to Engineer. Exterior coating shall not be applied until after the specified interior cement mortar lining (if required) has been applied and cured. Repairs of any damage to the shop coating and the field coating of ends where coatings have been held back shall be done by experienced and qualified personnel.

The pipe lining and coating company shall submit an affidavit of compliance indicating that all instructions and requirements of the coating materials manufacturer will be followed and that the company is acceptable to the materials manufacturer.

2.14.02.02 Shop-Applied Cement Mortar Lining. Unless otherwise acceptable to Engineer, cement mortar lining for all 36 inch (900 mm) and smaller steel pipe shall be shop applied. For pipe larger than 36 inches (900 mm), the lining shall be shop applied, or Contractor shall have the option of shop or field applied lining as specified herein. Except as modified herein, shop-applied mortar linings shall comply with ANSI/AWWA C205.

Specials. Wire fabric reinforcement shall be used in the lining of fittings and specials in accordance with Section 4.4.5 of ANSI/AWWA C205.

Adjacent to Valves. If the specified nominal pipe size is the actual outside diameter, cement mortar lining installed in steel pipe adjacent to butterfly valves shall be tapered so that the lining material will not interfere with the valve disc during valve operation.

2.14.02.03 Shop-Applied Tape Coat. Except as modified or supplemented herein, shop-applied tape coating shall comply with ANSI/AWWA C214. The tape coating system shall consist of a primer layer, an inner layer of tape for corrosion protection, and two outer layers of tape for mechanical protection. The total thickness of the tape coating system shall be at least 80 mils (2 mm). The outer layer of tape shall be white.

2.15 SHOP INSPECTION AND TESTING. Except as otherwise indicated or acceptable to Engineer, all materials and work shall be inspected and tested by the pipe manufacturer in accordance with ANSI/AWWA C200. All costs in connection with such inspection and testing shall be borne by Contractor.

Copies of all test reports shall be submitted as set forth in Master Specification Section 01080, Project Submittals.

Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

2.15.01 Owner's Inspection at the Shop. If Owner elects to inspect any work or materials, as permitted under Section 1.4 of ANSI/AWWA C200, all costs in connection with the services of Owner's inspector will be paid for by Owner. Additional weld test specimens shall be furnished to Owner's inspector for testing by an independent testing laboratory whenever, in the judgment of Owner's inspector, a satisfactory weld is not being made. Test specimens shall also be furnished when Owner's inspector desires. The entire cost of obtaining, inspecting, and testing of such additional specimen plates, welds, or materials will be borne by Owner. If any specimen is found not to conform to the specified requirements, the materials represented by the specimen will be rejected. The expense of all subsequent tests due to failure of original specimens to comply with the specifications shall be the responsibility of Contractor.

Work to be performed by Owner's inspector at the fabricating shop will include checking of flange alignment after welding to the pipe and tolerances of stab joints, when applicable.

In addition to making or witnessing all specified tests and submitting any required reports to Engineer and Owner, Owner's inspector will submit written reports to Contractor concerning all materials rejected, noting the reason for each rejection.

Inspection by Owner's inspector, or failure to provide inspections, shall not relieve Contractor of his responsibility to provide materials and to perform the work in accordance with the Contract Documents.

2.15.02 Welding Procedures, Welder Qualifications, and Testing. When additional welding requirements are required, they shall be as specified in this paragraph.

All welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in ANSI/AWWA C200. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.

All shop welds on steel pipe and fittings shall be ultrasonically tested by qualified and certified operators employed by the fabricator. Shop ultrasonic weld tests shall be in accordance with Section 9 of API 5L, 37th Edition. All costs for ultrasonic shop testing shall be paid by Contractor. Contractor and Engineer shall each be furnished a copy of all ultrasonic test reports.

Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing ultrasonic and radiographic tests shall be qualified and certified according to the requirements of SNT-TC-1A.

Nondestructive examination procedures shall be submitted in accordance with Master Specification Section 01080, Project Submittals at the time welding procedures are submitted. Records of inspection, nondestructive examination, and material certification shall be furnished to Engineer.

All costs for inspection of shop welds shall be paid by Contractor.

PART 3 - EXECUTION

3.1 FIELD INSPECTION. All shop-applied exterior coal tar enamel or tape coatings on pipe, fittings, or specials shall be electrically inspected for holidays and other defects, and repaired if necessary. All electrical inspection shall be made in accordance with Section 6 of ANSI/AWWA C203.

Inspection and repair of exterior coatings shall be performed by and at the expense of Contractor, after receipt of the pipe, fittings, or specials on the job and before installation. Electrical inspection of exterior coal tar enamel or tape coatings after installation of the pipe, fitting, or special in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged by handling during installation.

3.2 PROTECTION AND CLEANING. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted.

Precautions shall be taken to ensure that foreign matter does not enter the pipe during jointing, lining repair, or inspection operations.

3.3 ALIGNMENT AND GRADE. Pipe shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Curves in stab joint pipe may be formed by opening the joint. Maximum joint openings and deflections shall be as recommended by the pipe manufacturer. In welded pipe, deflections up to 4-1/2 degrees (0.079 rad) may be made by shop-mitering one end of one pipe. Deflections up to 22-1/2 degrees (0.393 rad) may be made by shop-mitering the ends of two adjacent sections of pipe by equal amounts. Deflections greater than 22-1/2 degrees (0.393 rad) shall be made by use of fabricated bends.

High points which allow air to collect in pipelines will not be permitted unless an air release valve is indicated on the drawings at that location.

When pipelines must be closely controlled, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.4 INSTALLATION.

3.4.01 Buried Piping. For buried piping, all trenching, embedment, and backfilling shall conform to Master Specification Section 02221, Trenching, Backfilling, and Compacting and the details indicated on the drawings.

Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug. All water in the trench shall be removed prior to removing the plug.

Pipe embedment and backfilling shall closely follow the installation and jointing of steel pipe in the trench to prevent flotation of the pipe by water and longitudinal movement caused by thermal expansion or contraction of the pipe.

For restrained joint pipe, not more than 160 feet (48 m) of pipe shall ever be exposed ahead of the backfilling in any section of trench. The backfill adjacent to field joints may be temporarily omitted to provide adequate space for field coating the joints. Closure welds on restrained joint pipe shall be made during the cool part of the day.

3.4.02 Out-of-Round Pipe. Pipe which deviates from a true circle by more than 1 percent shall be laid with its larger diameter vertical, or by using struts or jacks on continuous head and sill timbers to correct the vertical diameter where permitted by Engineer. Struts or jacks shall be left in place until the joints at each end have been completed and embedment and backfill for the section have been placed to at least 12 inches (300 mm) above the top of the pipe. Final inspection, repair, and checking of interior lining shall be performed after the struts or jacks have been removed.

3.4.03 Elongating Vertical Diameter. When required, the vertical diameter of all buried pipe with minimum cover depth as required or so indicated on the drawings, shall be elongated (before backfilling of the trench) by an amount equal to 2 percent of the nominal diameter.

The vertical diameter may be elongated by controlled placement of pipe embedment material or by struts or jacks installed between continuous head and sill timbers padded to protect the lining. Struts or jacks shall be left in place until the joints at each end have been completed and the embedment and backfill for the section have been placed to at least 12 inches (300 mm) above the top of the pipe. Final inspection, repair, and checking of interior lining shall be performed after the struts or jacks have been removed.

3.4.04 Pipe Deflection. After completion of backfilling and before acceptance of the Work, all pipe larger than 30 inches (750 mm) in diameter shall be tested for excessive deflection by measuring the actual inside vertical diameter. Deflection measurements will be made by Engineer. Pipe with diametral deflection exceeding 2 percent of the nominal inside diameter shall be uncovered and the bedding and backfill replaced as needed to prevent excessive deflection. After replacing bedding and backfill, the pipe shall be retested.

3.4.05 Flanged Joints. Care shall be taken in bolting flanged joints to avoid restraint on the opposite end of the piece, which would prevent pressure from being evenly and uniformly applied upon the gasket. The pipe or fitting must be free to move in any direction during installation of bolts. Bolts shall be gradually tightened in a crisscross pattern, to ensure a uniform rate of gasket compression around the entire flange.

Special care shall be taken when connecting piping to pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before any bolts are installed in the flanges. In addition, pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts then shall be loosened and the process repeated until no movement is observed.

3.4.06 Couplings. Surfaces of pipe ends and couplings in contact with the sealing gasket shall be clean and free from foreign material when the coupling is installed on the pipe. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. All bolts shall be tightened by approximately the same amount, with all parts of the coupling square and symmetrical with the pipe. Following installation, the exterior coating of each coupling shall be touched up or reprimed.

3.4.07 Insulated Flanged Joints. Insulated flanged joints shall be installed where indicated on the drawings. In addition to one full-faced insulating gasket, each flange insulating assembly shall consist of one full-length sleeve, one insulating washer, and two backing washers for each flange bolt. The insulating gasket ID shall be 1/8 inch (3 mm) less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the manufacturer.

3.4.08 Stab Joints. Gasket installation and other jointing procedures shall conform to the instructions and recommendations of the pipe manufacturer. All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before making the joint. The lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Measurements shall be taken at the joints after installation to ensure that the specified clearances have not been exceeded.

3.4.09 Welded Joints. All welds shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be watertight. Butt welds shall be used for all welded joints in pipe assemblies and in the fabrication of bends and other specials. Field-welded joints, where permitted, shall be either butt-welded or lap-welded.

Field welding of joints shall conform to ANSI/AWWA C206. Single field-welded butt joints with outside backing rings may be used for pipe larger than 27 inches

(675 mm) in diameter. Backing rings will not be permitted for 27 inch (675 mm) and smaller pipe. Butt straps shall be welded on both the inside and outside of the pipe and at each end of the pipe and strap to avoid stress multiplication.

Field-welded lap joints shall have fillet welds both inside and outside to avoid stress multiplication. The outside weld may be a seal weld.

Testing of welded joints shall be standard, or special procedure, as specified herein.

3.4.09.01 Standard Inspection and Testing. When specified herein, standard shop inspection and testing shall be in accordance with the shop inspection and testing provisions herein.

Field weld test specimens shall be furnished to Engineer for testing by an independent testing laboratory whenever, in the judgment of Engineer, a satisfactory weld is not being made. Test specimens shall also be furnished when Engineer desires. All costs for this testing will be paid by Owner.

3.4.09.02 Special Procedure Inspection and Testing. When specified herein, special procedure shop inspection and testing shall be in accordance with the shop inspection and testing provisions specified herein. Field welding procedures, welders, welding operators, and tackers shall be qualified in accordance with AWS D1.1 and as defined in Section 3 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable. All qualifications shall be in accordance with all-position pipe tests as defined in Section 5 of AWS D1.1.

The welder qualification testing for field welding shall be conducted at the project site. Results of previous qualification tests will not be accepted. Contractor shall provide the services of an independent testing laboratory to perform the welder qualification. Copies of all test data and certifications shall be submitted to Engineer. All costs of welder qualification testing shall be paid by Contractor.

Upon completion of each field-welded joint, the welding operator shall mark his regular identification number and the last two digits of the year the work was completed, or Contractor may have a records system that traces a welder's work. Steel stamping directly on piping will not be permitted unless "low stress" die stamps, such as interrupted dot or round-nose types, are used.

Field welds will be randomly inspected and tested by an independent testing laboratory as directed by Engineer. Field lap welds will be inspected by magnetic particle or dye penetration methods. Field butt welds will be inspected by the radiographic method and in accordance with the acceptance criteria of API 1104. Contractor shall inform Engineer before welded joints are to be backfilled so that the joint may be inspected. Contractor shall assume all costs of exposing joints that were backfilled before inspection.

Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing nondestructive tests shall be qualified and certified to the requirements of SNT-TC-1A.

Engineer may also order nondestructive testing by an independent testing laboratory in addition to any testing specified herein.

Except as otherwise specified herein, all costs for inspection and testing of field welds by the independent testing laboratory will be paid by Owner. If the weld is defective, the inspection costs shall be paid by Contractor. Defective welds shall be repaired and retested at Contractor's expense.

Test reports of all laboratory tests shall be submitted as provided for in Master Specification Section 01060, Quality Control.

3.4.10 Flanged Coupling Adapters. Flanged coupling adapters shall be provided where indicated on the drawings and shall be installed in accordance with the coupling manufacturer's recommendations. After the pipe is in place and all bolts have been properly tightened, the location of holes for the anchor studs shall be determined and field drilled. Hole diameter shall be not more than 1/8 inch (3 mm) larger than the diameter of the stud projection. Anchor stud holes shall extend completely through the pipe wall and lining material.

The inner surfaces of the coupling shall be prepared for painting in accordance with the paint manufacturer's instructions and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except flange mating surfaces, shall be cleaned and shop primed with a universal primer.

3.5 WALL SLEEVES. Wall sleeves shall be provided where indicated on the drawings and shall be provided where steel pipe passes through concrete or masonry walls, unless otherwise noted. Where harness lugs are attached to wall sleeves, the sleeves shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint wall sleeves, holes in the mechanical joint bells and flanges shall straddle the top (or side for vertical piping) center line. The top (or side) center line shall be marked on each flange and mechanical joint piece at the fabricating shop.

3.6 PIPE ANCHORS, BLOCKING, ENCASEMENT, HANGERS, AND SUPPORTS. Pipe anchors, blocking, hangers, and supports shall be installed where and as indicated on drawings and shall be fabricated in accordance with Master Specification Section 15140, Pipe Supports and the details indicated on the drawings, and shall be furnished and installed complete with all concrete bases, anchor bolts and nuts, plates, rods, and other accessories required for proper support of the piping. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports. Where the details must be modified to fit the piping and structures, all such modifications shall be subject to acceptance by Engineer. Unless otherwise permitted, lugs for lateral or longitudinal anchorage shall be shop welded to the pipe.

Concrete reaction anchorage, blocking, encasements, and supports shall be provided as indicated on the drawings or as permitted by Engineer. Concrete and reinforcing steel for anchorages, blocking, encasements, and supports shall conform to Master Specification Section 03300, Cast In Place Concrete and Master Specification Section 03200 Concrete Reinforcement. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.7 PROTECTIVE COATINGS AND LININGS.

3.7.01 Field Coating and Repair. Entry into the pipe or pipeline for application of interior linings to unlined ends shall be from open ends or through access manholes, except as otherwise permitted by Engineer. Pour holes shall be permitted as specified herein, and shall consist of 4 inch (100 mm) standard weight black steel pipe welded to the pipe to be lined and covered with a bolted blind flange*.*

Field repair of shop-applied exterior coatings and interior linings shall conform to the following:

For Field-Welded Joints

Coal Tar Enamel	Hold back coating and lining 4 inches (100 mm) from joint. Field repair in accordance with ANSI/AWWA C203.
Cement Mortar	Hold back coating and lining 4 inches (100 mm) from joint. Field repair in accordance with Section 4.6 of ANSI/AWWA C205 as modified herein.
Liquid Epoxy	Hold back coating 4 inches (100 mm) from joint. Field repair in accordance with ANSI/AWWA C210.
Tape Coating	Hold back at least 4 inches (100 mm) from joint. Field repair in accordance with ANSI/AWWA C209, except the total applied tape thickness shall be not

	less than 80 mils (2 mm).
For Flanged Joints	Extend lining to ends of pipe. The coating of exterior surfaces is covered in Master Specification Section 09900, Painting.
For Stab Joints	
Coal Tar Enamel	Hold back the coating on spigots and the lining in bells from joints in accordance with ANSI/AWWA C203. Field repair exterior coating with 20 mils (500 µm) of medium consistency coal tar. Repair lining in accordance with ANSI/AWWA C203.
Cement Mortar	Hold back the coating on spigots and the lining in bells from joints as specified for coal tar enamel coatings in ANSI/AWWA C203. Field repair in accordance with Section 4.6 of ANSI/AWWA C205 as modified herein.
Liquid Epoxy	Hold back the coating on spigots and the lining in bells from joints, and field repair in accordance with ANSI/AWWA C210.
Tape Coating	Hold back the coating on spigots as specified for coal tar enamel in ANSI/AWWA C203. Field repair in accordance with ANSI/AWWA C209.
For Mechanically Coupled Joints	
Coal Tar Enamel	Hold back coating 16 inches (400 mm) from joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Lining shall extend to end of pipe. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.

Cement Mortar	Hold back coating 16 inches (400 mm) from joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Lining shall extend to end of pipe. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Liquid Epoxy	Shop coat in accordance with ANSI/AWWA C210. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Tape Coating	Hold back coating 16 inches (400 mm) from joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.

For Grooved Coupled Joints

Coal Tar Enamel	Hold back coating 6 inches (150 mm) at joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Lining shall extend to end of pipe. Field repair exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Cement Mortar	Hold back coating 6 inches (150 mm) at joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with

	ANSI/AWWA C203. Lining shall extend to end of pipe. Field repair exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Liquid Epoxy	Shop coat in accordance with ANSI/AWWA C210. Field repair exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.
Tape Coating	Hold back coating 12 inches (300 mm) at joints; paint exposed surfaces with 2.5 mil (63 µm) dry film thickness of Type B primer in accordance with ANSI/AWWA C203. Field coat exterior surfaces with 20 mil (500 µm) dry film thickness of medium consistency coal tar. Repair of lining at joints not required.

3.7.02 Modifications to the Governing Standards.

3.7.02.01 Field Repair of Shop-Applied Cement Mortar Lining. Field repair of interior joint surfaces shall be done in accordance with Section 4.6.2 of ANSI/AWWA C205, except that an epoxy bonding agent and latex admixture shall be used in conjunction with the sand and cement mortar. The addition of lime or pozzolan will not be permitted.

The exposed steel shall be thoroughly cleaned and all grease shall be removed. A coat of epoxy bonding agent shall be applied over the area to be lined in accordance with the manufacturer's recommendations. A soupy mixture of cement and water shall be applied over the epoxy after it becomes tacky. Cement mortar to which the latex admixture has been added shall then be packed into the area to be patched and screeded off level with the adjacent cement mortar lining. The patched area shall be given an initial floating with a wood float, followed by a steel trowel finish.

Defective or damaged shop-applied cement mortar linings shall be removed, the surfaces cleaned, and the lining repaired as specified above for joint repair.

3.7.02.02 Field-Applied Cement Mortar Lining. Except as modified herein, field-applied mortar linings shall comply with ANSI/AWWA C602.

Specials. Wire fabric reinforcement shall be used in the lining of fittings and specials in conformance with Section 4.4.5 of ANSI/AWWA C205.

Field Repair. Defective or damaged field-applied cement mortar linings shall be removed, the surfaces cleaned, and the lining repaired as specified for shop-applied cement mortar linings.

3.8 CONNECTIONS WITH EXISTING PIPING. Connections between new work and existing piping shall be made with suitable fittings for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner.

Facilities shall be provided for dewatering and for disposal of the water removed from the dewatered lines and excavations without damage to adjacent property.

For pipelines which will convey potable water, special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with or dipped in a 200 mg/L chlorine solution.

3.9 PROVISIONS FOR CATHODIC PROTECTION. Provisions shall be made for cathodic protection of underground steel pipelines. An insulated type joint shall be provided at each connection to a steel water tank, each branch connection to an existing or future water line, each connection between concrete pipe or ductile iron pipe and steel pipe, each connection through a structure wall, and where indicated on the drawings. An electrical bond shall be provided across all other gasketed pipeline joints. Test lead stations for monitoring electrical currents on the pipeline shall be provided at locations indicated on the drawings.

3.9.01 Insulated Joints. Insulated flange type joints shall be provided where indicated on the drawings or specified. After installation, protective coatings shall be provided around the joint as specified herein.

3.9.02 Electrical Bond Across Rubber-Gasketed Joints. Two electrical bonding cables shall be provided to and across each mechanical coupling and across each rubber-gasketed stab joint. Before the field joint coating is applied to mechanical couplings, two small areas of metal shall be exposed on the pipe surface each side of the coupling, on the middle ring, and on each follower ring. Before the field joint coating is applied to stab joints, two small areas of metal shall be exposed on each side of the joint. Each area shall be thoroughly cleaned, and two cathodic protection cables shall be bonded to the pipe, one on either side of the joint, and to the middle ring and follower rings for mechanically coupled joints. Each cable shall be bonded by the thermite process. The completed connections and exposed metal surfaces shall be coated as specified for field repair of coatings.

3.9.03 Electrical Bond Across Valves and Flanges. Two electrical bonding cables shall be provided across valves and flanged connections other than insulated flanges. The electrical bond shall be provided as specified for bond across rubber-gasketed joints.

3.9.04 Bonding Cables. Bonding cable and test lead wires shall be not less than 6 AWG (16 mm^2), Type CP copper cathodic protection cable, with low density, high molecular weight polyethylene insulation.

3.9.05 Test Lead Stations. Test lead stations shall be provided where specified or indicated. The test lead stations shall be as specified herein. The test lead wires shall be terminated on the ground surface in a standard connection box at a protected location acceptable to Engineer. Standard connection boxes for test lead stations shall be C.P. Test Services "NM-7" plastic terminal boxes, 18 inches (450 mm) long, with 5 inch (125 mm) inside diameter, a locking cast iron lid, a terminal block with seven terminals, and the inscription "CP TEST" cast into its cover.

3.10 LEAKAGE AND PRESSURE TESTS. After installation, steel piping shall be subjected to a leakage and pressure test.

3.10.01 Leakage. All steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.10.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.11 DISINFECTION. The steel piping shall be disinfected after installation as specified herein. The disinfection is to be as specified in Master Specification Section 02675, Disinfection of Water Distribution System.

End of Section

SECTION 15063

LIGHT WALL STEEL PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of light wall steel pipe, fittings, specials, and appurtenances.

Miscellaneous small piping and pipe supports are covered in Master Specification Section 15065, Miscellaneous Steel Pipe, Tubing, and Accessories and Master Specification Section 15140, Pipe Supports .

Light wall steel piping shall be furnished and installed complete with all fittings, specials, flanges, couplings, joint harnesses, anchors, anchor bolts, anchor inserts in concrete, expansion anchors, flange gaskets, flange bolts and nuts, pipe supports and hangers, wall fittings, blind flanges, connections, appurtenances, and accessories, as indicated on the drawings, or otherwise specified herein for proper installation and functioning of the piping.

Piping furnished shall be complete with all jointing materials required for installation of any valves and equipment furnished by others for installation under this contract.

1.2 GOVERNING STANDARDS. Except as modified or supplemented herein, all light wall steel pipe, fittings, and specials shall conform to the applicable requirements of the following standards:

ANSI/AWWA Standards	Title
C200	Steel Water Pipe 6 Inches [150 mm] and Larger
C206	Field Welding of Steel Water Pipe
C208	Dimensions for Steel Water Pipe Fittings

1.3 SUBMITTALS. Drawings, specifications, and other data showing complete details of the fabrication, construction, weld locations, and installation of pipe, fittings, specials, and connections, together with complete data covering all materials proposed for use, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Pipe, fittings, specials, and appurtenances shall at all times be handled and stored in a manner that will ensure installation in sound, undamaged condition. Handling methods and equipment used shall prevent damage to the coating and shall include the use of wide canvas slings and wide padded skids. Bare cables, chains, hooks, metal bars, or narrow skids shall not be used.

All pipes shall be carefully supported during shipment on padded saddles not less than 12 inches (300 mm) wide. Each end of each length of pipe, fitting, or special shall be laterally supported and braced as needed to ensure that it will maintain a true circular shape. Pipe, fittings, and specials shall be separated so that they do not bear against each other, and the whole load shall be securely fastened to prevent movement in transit.

Any pipe section, fitting, or special, which shows dents, kinks, abrupt changes of curvature other than specified, or other injuries, will be rejected. Contractor shall, at his expense, replace or recondition each rejected section. Reconditioning procedures shall be acceptable to Engineer. Coatings removed in reconditioning pipe, fittings, or specials shall be replaced as specified for the original coating.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN. Light wall steel pipe, fittings, and specials may be either fabricated or mill type. In either case, all items shall be fabricated to the sizes, dimensions, and shapes indicated on the drawings. Elbows shall be long radius, with the centerline to face dimensions equal to 1.5 times the pipe diameter unless otherwise indicated.

The ratio of pipe diameter to wall thickness shall not exceed 200. Unless otherwise indicated in the Light Wall Steel Pipe Schedule 15063-S01, the wall thickness shall be not less than 0.134 inch (10 gage) (3.42 mm).

Specified nominal pipe size for 14 inch (350 mm) and larger pipe, fittings, and specials shall be the actual outside diameter, in inches (mm).

The outside diameter of 12 inch (300 mm) and smaller pipe shall conform to the dimensions set forth in ANSI/ASME B36.10 for standard weight steel pipe.

Bends, fittings, branch connections, and special sections shall be reinforced or shall have their shell thickness increased so that the combined stresses due to internal pressure and bending will not exceed 50 percent of the yield strength of the material. Contractor shall determine and provide reinforcements or additional shell thickness as needed to keep the combined stresses within the specified maximum. Unless otherwise indicated on the drawings or directed, the internal working pressure for design purposes shall be as indicated in the Light Wall Steel Pipe Schedule 15063-S01. The dead load shall be equal to the weight of the pipe.

2.2 MATERIALS. Unless otherwise required by the drawings, field joints shall be either flanged or mechanically coupled.

Pipe	ANSI/AWWA C200, ASTM A139.
Fittings and Specials	ANSI/AWWA C200.
Dimensions	AWWA C208.
Flanged Joints	
Flanges	Flat faced when connecting to flat faced flanges; otherwise, raised face. Steel plate of the following thickness:

Nominal Pipe Size	Flange Thickness
inches [mm]	inches [mm]
6 [150]	1/4 [6]
8,10 [200, 250]	5/16 [7.8]
12 [300]	3/8 [9.3]
14-20 [350 - 500]	7/16 [10.9]
24 [600]	1/2 [12.7]
30, 36 [750, 900]	5/8 [15.6]
42, 48 [1200]	3/4 [19]

Material	ASTM A36.
Diameter and Drilling	ANSI/ASME B16.1, Class 25.

Flange Bolting

Material	ASTM A307.
Type	Bolt and nut; bolt-stud and two nuts permitted for 1 inch and larger.
Bolts and Bolt-Studs	
Length	Such that ends project 1/4 to 1/2 inch [6 to 12.7 mm] beyond surface of nuts.
Ends	Chamfered or rounded.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2A fit. Bolt-studs may be threaded full length. Studs for tapped holes shall be threaded to match threading in holes.
Bolt Heads	
Shape	Hexagonal or square.
Dimensions	ANSI/ASME B18.2.2; regular pattern for square, heavy pattern for hexagonal.
Nuts	Hexagonal.
Dimensions	ANSI/ASME B18.2.2, heavy, semifinished pattern.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2B fit.

Gaskets

For Aeration/Backwash Air Service

Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact fact, 1/16 inch [1 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces, rated for 275°F [135°C] service; Garlock "IFG 5507".

Flat Faced Flanges	Premium Grade, EPDM, ring type, 1/8 inch (3 mm) thick, rated for 275°F (135°C) service, Garlock "8314".
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Coupled Joints	
Mechanical Couplings	Dresser "Style 38 Light Pattern Couplings" or Smith-Blair "411 Flexible Coupling", without pipe stop. Elastomers for air piping shall be rated at 275°F (135°C).
Joint Harness	
Bolts	ASTM A193, Grade B7, or Ryerson "Stress-Proof". Minimum yield point 100,000 psi (689 Mpa).
Threading	ANSI/ASME B1.1, Class 2A fit, coarse thread series.
Ends	Chamfered or rounded.
Nuts	Hexagonal, ASTM A307.
Threading	As specified for bolts except Class 2B fit.
Dimensions	ANSI/ASME B18.2.2, heavy, semifinished pattern.
Flat Washers	Steel, ANSI B18.22.1.
Grooved Couplings	ANSI/AWWA C606, Gustin-Bacon "Gruvagrip Series 100" or Victaulic "Style 77", as needed.
Small Branch Connections	

Pipe Nipples	Seamless black steel pipe, ASTM A53, standard weight (Schedule 40).
Welding Fittings	
Threaded Outlets	Bonney "Thredolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Welded Outlets	Bonney "Weldolets", Porter "W-S Teelets", or Vogt "Weld Couplets".
Expansion Joints	Mercer "Style 450N" or Redflex "No. J-1", single arch, spool type with elastomeric body rated for 300°F [149°C], split steel retaining rings, and control rods, unless otherwise indicated.
Watertight/Dusttight Pipe Sleeves and Sealing Elements	O-Z Electrical Manufacturing "Thruwall" and Floor Seals",or Thunderline Corporation "Link-Seal", with modular rubber sealing elements with galvanized bolts.
Pipe Sleeve Sealant	Polysulfide or urethane, as specified in Master Specification Section 07600, Caulking and Sealers.
Insulation	
Hot Pipe	ASTM C547, Class 1 (to 450 F), 1 inch (25 mm) thick; glass fiber, one-piece molded with vapor barrier, flame-retardant all service jacket and self-sealing tabs; CertainTeed "500 Snap-On" or Owens-Corning "Fiberglas 25 ASJ/SSL".
Jacket	Aluminum, ASTM B209, Alclad 3004, 0.020 inch (0.051 mm) thick, machine rolled, with asphalt and kraft paper vapor barrier.
Cold Piping	Fed Spec HH-I-573, tubular, closed cell elastomeric, at least 3/4 inch (19 mm) thick.
Fittings, Flanges, and	ASTM C547, Class 1 (to 450°F (232°C)),

Valves	1 inch (25 mm) thick, factory molded glass fiber fitting insulation; CertainTeed "Snap Form" or Poncho "Poncho Preformed".
Anchor Bolts	Carbon steel, as specified in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

2.3 ENDS OF SECTIONS.

2.3.01 For Field Welding. Ends of pipe, fittings, and specials for field butt welding shall be outside beveled to an angle of 35 degrees, plus or minus 2-1/2 degrees, with the plane of the pipe end, with an average flat at the end of the pipe of 1/16 inch (1.5 mm) plus or minus 1/32 inch (0.75 mm).

2.3.02 For Fitting with Flanges. Ends to be fitted with flanges shall have the longitudinal or spiral welds ground flush as needed to accommodate the type of flanges provided.

2.3.03 For Mechanical Couplings. Ends to be joined by mechanical couplings shall be plain end type. In addition, the welds on ends to be joined by couplings without pipe stops shall be ground flush to permit slipping the coupling in at least one direction to clear the pipe joint. Outside diameter and out-of-round tolerances shall be within the limits specified by the coupling manufacturer.

2.3.04 For Grooved Couplings. Ends to be joined by grooved couplings shall be of the roll grooved type as recommended by the coupling manufacturer.

2.4 PIPE LENGTH TOLERANCE. Standard and special sections shall be within 1/8 inch (plus or minus) of the specified or theoretical lengths. All pipe to be connected with mechanical couplings shall be fabricated so that space between pipe ends within the couplings will not exceed the allowable, as recommended by the coupling manufacturer, but will be at least 1/8 inch (3 mm).

2.5 SPECIAL SECTIONS. All fittings and specials shall be provided with ends as specified, and shall be fabricated to the shapes, sizes, and dimensions indicated on the drawings.

2.6 SMALL BRANCH CONNECTIONS. Small branch connections 2 inches and smaller shall be made using welding fittings with threaded outlets. Where there is some doubt as to the exact outlet size required, but it is known that the size will be less than 1 inch, a 1 inch (25 mm) outlet shall be provided, and reducers used as needed.

Branch connections 2-1/2 inches (63 mm) and larger shall be made using pipe nipples or welding fittings. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as required to meet design and test requirements.

Small branch connections shall be located so as not to interfere with joints, supports, or other details.

2.7 DRAINS. Drains shall be provided at the locations indicated on the drawings. Drain valves shall be hose gate valves. Drain valves shall comply with the requirements of the Master Specification Section 15100, Miscellaneous Valves.

Pipe used for drain piping shall be standard weight, galvanized steel pipe.

2.8 FIELD JOINTS. Flanged, welded, and mechanically coupled joints shall be provided at the locations indicated on the drawings. To facilitate installation, additional field welded and mechanically coupled joints may be provided when required. These field joints shall be kept to a minimum, and their location shall be acceptable to Engineer.

2.9 FLANGED JOINTS. Flanged joint faces shall be normal to the pipe axis, with a maximum tolerance of 0.005 inch per foot (0.125 mm/300 mm) of flange diameter. Angular deflection (or layback) of the flange face shall not exceed 0.75 degree from a plane surface and shall be uniform within 0.010 inch (2.5 mm). All flanges, after welding to the pipe, shall be measured and shall be refaced, if necessary, to bring them within the specified tolerances.

Contractor shall coordinate diameter and drilling of flanges furnished in the piping with the flanges for any valves, blowers, vacuum pumps, and other equipment to be installed in the piping.

Blind flanges shall conform in diameter, drilling, and thickness to the flanges to which they attach and shall be reinforced as needed to produce an airtight joint.

2.10 MECHANICAL COUPLINGS.

2.10.01 Couplings. Unless otherwise shown on the drawings, the middle ring of each mechanical couplings shall have a thickness at least equal to that specified for the size pipe on which the coupling is to be used and shall be not less than 7 inches (175 mm) long. The pipe stop shall be omitted from the inner surface of the middle rings of all couplings. The couplings shall be cleaned and shop primed with the manufacturer's standard universal primer.

2.10.02 Joint Harnesses. Where noted or indicated on the drawings, mechanically coupled joints shall be restrained with harness bolts and lugs. Joint harnesses shall conform to the details on the drawings. Lugs shall be shop welded to the pipe and coated as specified for the adjacent pipe.

2.10.03 Grooved Couplings. Grooved couplings shall be sized for proper installation on the grooved pipe provided.

After fabrication, all housing clamps forming the coupling shall be cleaned and primed by the coupling manufacturer as specified for the pipe.

2.11 WELDED JOINTS. All welds shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be airtight. Butt welds shall be used for all welded joints in line pipe assemblies and in the fabrication of bends and other specials. Fillet welds shall be used for flange attachment. Welding of field joints shall conform to ANSI/AWWA C206.

2.12 PIPE SUPPORTS, ANCHORS, AND HANGERS. Pipe supports, anchors, and hangers shall be fabricated in accordance with the requirements of Master Specification Section 15140, Pipe Supports, or the details indicated on the drawings. Pipe supports, anchors, and hangers shall be furnished and installed complete with all concrete bases, anchor bolts and nuts, plates, rods, and other accessories required for proper installation. Where the details must be modified to fit the piping and structures, all such modifications shall be subject to review and acceptance by Engineer. Lugs required for lateral or longitudinal anchorage shall be shop welded to the pipe.

2.13 PIPE SLEEVES. Piping passing through concrete or masonry shall be installed through sleeves installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors provided with a special finish, such as ceramic or vinyl-composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. In all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch (25 mm) nor more than 2 inches (50 mm) above the floor surface, with the projection uniform in each floor area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the drawings indicate future installation of pipe, sleeves shall be provided and the ends sealed with suitable plastic caps or plugs.

Holes drilled with a suitable rotary drill will be considered in lieu of sleeves for piping which passes through interior walls and through floors having a special finish.

Unless otherwise indicated on the drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

Piping passing through walls and floors shall be made dusttight and gastight when specified herein, with special rubber-gasketed sleeve and joint assemblies, with sleeves sealed with modular rubber sealing elements, or by caulking with oakum and sealing each end with polysulfide or urethane sealant.

2.14 PROTECTIVE COATINGS. All steel pipe, fittings, specials, and wall fittings shall be prepared and prime coated as specified herein.

2.14.01 Type of Coating. The type of protective coating to be used shall be as follows:

Exterior Surfaces in Interior and Exterior Locations. Exterior surfaces, except machined surfaces, of all pipe, fittings, specials, flanges, anchors, and pipe supports exposed in interior locations and in manholes shall be thoroughly blast cleaned and given a coat of universal primer.

Field painting shall be as specified in the Master Specification Section 9900, Painting.

Interior Surfaces. The interior surfaces of all steel pipe, fittings, and specials shall not be coated.

Machined Surfaces. All machined surfaces shall be shop coated with rust-preventive compound.

2.15 INSULATION. The following systems shall be insulated:

Hot piping	Explosed blower discharge piping less than 8 feet (2.4 m) above finished floor or grade.
Cold Piping	Blower suction piping.

2.16 INSPECTION AND TESTING. Inspection and testing by an independent laboratory will not be required at the fabricating or coating shop; however, the pipe manufacturer shall furnish an affidavit of compliance certifying that all materials used and work performed comply with the specified requirements. Seven copies of the affidavit shall be furnished.

PART 3 - EXECUTION

3.1 INSTALLATION. All piping shall be installed in the location and arrangement indicated on the drawings.

Taps for pressure gauge connections on the suction and discharge of blowers shall be provided with a nipple and a ball type shutoff valve.

Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

3.1.01 Concrete. Concrete reaction anchorage and supports shall be provided where and as indicated on the drawings.

3.1.02 Flanged Joints. Care shall be taken in bolting flanged joints so that there is no restraint on the opposite end of the piece which would prevent pressure from being evenly and uniformly applied to the gasket. The pipe or fitting must be free to move in any direction during installation of bolts. Bolts shall be gradually tightened, each in turn, at a uniform rate of gasket compression around the entire flange.

Special care shall be taken when connecting to equipment to ensure that piping stresses are not transmitted to the equipment flanges by the connected piping. All such piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of flanges are obtained before installation of any bolts in those flanges. In addition, equipment connection piping shall be free to move parallel to its longitudinal center line while the bolts are tightened. Equipment shall be leveled, aligned, and wedged in position to fit the connecting piping. Equipment shall not be grouted until the initial fitting and alignment of the pipe so that the equipment may be shifted on its foundation if necessary to properly install the connecting piping. Each piece of equipment shall be grouted before final bolting of the connecting piping. After final alignment and bolting, the equipment connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the equipment or opening of the equipment connection joints.

3.1.03 Couplings. The ends of the pipe on which couplings are to be placed, and the couplings themselves, shall be clean and free from any dirt or foreign material, especially those surfaces of the pipe and coupling that contact the gaskets. Gaskets shall be kept clean with no foreign matter between them and the packing surfaces. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. All bolts shall be tightened approximately the same amount, with all parts of the coupling square and symmetrical with the pipe. After installation, couplings shall be carefully touched up or reprimed.

3.1.04 Insulation. Pipe insulation shall be provided where indicated on the drawing and shall be neatly installed in accordance with the manufacturer's recommendations. Piping shall be clean and dry and shall have been tested, when testing is required, before insulation is applied.

End and longitudinal joints shall be tightly butted and sealed with lap and butt strips of self-sealing jacket material.

Fittings, flanges, and valves shall be insulated with molded insulation and all service, one-piece jackets installed in accordance with the manufacturer's recommendations. Fitting insulation shall overlap adjacent pipe insulation at least 1 inch (25 mm). Valves shall be insulated up to the gland only.

Pipe hangers shall permit insulation to pass through and suitable saddles shall be provided to prevent the weight of the piping from being supported by the insulation.

3.2 CLEANING. All pipelines shall be clean and free of dirt, rocks, debris, or other foreign material of any kind when placed in service.

The interior of all pipe and fittings shall be thoroughly cleaned of all foreign matter before being installed and shall be kept clean until the work has been accepted.

3.3 PRESSURE AND LEAKAGE TESTING. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction, of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation. Air piping shall be tested using compressed air.

Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing.

All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor and at the time directed by Engineer.

All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

End of Section

SECTION 15064

STAINLESS STEEL PIPE, TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of stainless steel pipe, tubing and accessories for the services as indicated in the Contract Documents. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Flange gaskets.

Insulating couplings.

Pipe sleeves.

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Stainless steel pipe materials shall be as indicated.

Material Classification	SS-1
Schedule 10S Stainless Steel With Buttwelded Fittings	
Pipe	ASTM A312, Grade TP304L
Fittings	ASTM A774, wrought stainless steel, grade equivalent to pipe, with beveled ends and Schedule 10S wall thickness.
Material Classification	SS-2
Schedule 10S Stainless Steel With Flanged Fittings	
Pipe	ASTM A312 or ASTM A778, Grade TP304L or TP316L.
Fittings	ASTM A774, wrought stainless steel, grade equivalent to pipe, with angle face rings and stainless steel backing flanges.
Material Classification	SS-3
Schedule 40S Stainless Steel With Threaded Fittings	
Pipe	ASTM A312, Grade TP304 or TP316.
Fittings	AISI Type 304 or 316 to match pipe, Class 150, dimensions conforming to ANSI/ASME B16.3.

Material Classification	SS-4
Schedule 40S Stainless Steel With Socket Welded Fittings	
Pipe	ASTM A312, Grade TP304L or TP316L.
Fittings	ASTM A182, F304L or F316L to match pipe, and ANSI B16.11, Class 3000.
Material Classification	SS-5
Schedule 40S Stainless Steel With Buttwelded Fittings	
Pipe	ASTM A312, Grade TP304L or TP316L.
Fittings	ASTM A403, WP304L or WP316L to match pipe, and ANSI/ASME B16.9, Schedule 40S.
Material Classification	SS-6
Stainless Steel Tubing With Compression Fittings	
Tubing	ASTM A269, seamless, Grade TP304 or TP316, annealed, max hardness Rockwell B80; with the following min wall thicknesses:

Tube OD inches (mm)	Wall Thickness inches (mm)
1/4 to 3/8 (6 to 9)	0.065 (1.65)
1/2 to 7/8 (13 to 22)	0.083 (2.11)
1 to 2 (25 to 50)	0.109 (2.77)

Fittings	Compression type, AISI Type 316 stainless steel; Crawford "Swagelok", or Parker Hannifin "CPI" or "Ferulok".
Material Classification	SS-7

Schedule 10S Stainless Steel
With Buttwelded Fittings

Pipe	ASTM A312, Grade TP304L.
Buttwelded Fittings	ASTM A403, WP304L, and ANSI B16.9, Schedule 10S.

2.1.02 Accessory Materials. Accessory materials for the stainless steel pipe systems shall be as indicated.

Material Classification SS-1 and SS-2

Backing Flanges: Stainless steel plate, AISI Type 304 or 316 to match fittings, with ANSI/ASME B16.5, Class 150 diameter and drilling; with the following thicknesses:

Nominal Pipe Size inches (mm)	Flange Thickness inches (mm)
1/2-8 (13-200)	1/2 (13)
10-14 (250-350)	5/8 (16)
16-18 (400-450)	3/4 (19)
20-30 (500-750)	1 (25)
36 (900)	1-1/4 (32)

Flange Bolts and Nuts: ASTM A307, galvanized, length such that, after installation, bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of nut.

Flange Gaskets: Flexitalic "Style CG", spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch (5 mm) nominal thickness, with compression ring 1/8 inch (3 mm) thick to match required flange dimensions.

Material Classification SS-7

Flanges	ANSI B16.5, Class150, flat face, AISI Type 304.
Flange Bolts	ASTM A193, AISI Type 304, ANSI B18.2.1 heavy hex head, length such that, after installation, bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of nut.
Nuts	ASTM A194, AISI Type 304, ANSI B18.2.2 heavy hex pattern.
Flange Gaskets	Flexitalic "Style CG", spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch (5 mm) nominal thickness, with compression ring 1/8 inch (3 mm) thick to match required flange dimensions.
Material Classification	SS-3, SS-4, and SS-5
Flanges	ANSI/ASME B16.5, Class 150, flat faced, AISI Type 304, 304L, 316, or 316L, to match piping.
Flange Bolts	ASTM A193, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
Flange Nuts	ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch (3 mm) thick.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation .

3.2 LEAKAGE AND PRESSURE TESTS. After installation, stainless steel piping shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All stainless steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15065

MISCELLANEOUS STEEL PIPE, TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that is less than 24 inches (600 mm) in diameter for the services as specified herein. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Expansion joints.

Flange gaskets.

Glass lined pipe and fittings.

Grooved and mechanical couplings.

Insulating (dielectric) couplings, threaded and flanged.

Name of Manufacturer.

Type and Model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

1.4.01 Coated Pipe. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Miscellaneous steel pipe materials shall be as indicated.

Material Classification	CSG-1
Standard Weight Galvanized Steel With Threaded Cast Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness.
Fittings	Threaded type, ANSI/ASME B16.4, Class 125.
Material Classification	CSG-2
Standard Weight Galvanized Steel With Threaded Malleable Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness.

Fittings	Threaded type, ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type II.
Material Classification	CSG-3
Standard Weight Galvanized Steel With Flanged Cast Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness.
Fittings	Flanged type, ANSI/ASME B16.1, Class 125.
Material Classification	CS-1
Standard Weight Steel With Threaded Malleable Iron Fittings	
Pipe	ASTM A53, Type E, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type I.
Material Classificaion	CS-2
Standard Weight Steel With Forged Steel Socket Welded Fittings	
Pipe	ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.
Material Classification	CS-3
Standard Weight Steel With Buttwelded Fittings	

Pipe	ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI/ASME B16.9; standard weight.
Material Classification	CS-4
Extra Strong Steel With Forged Steel Threaded Fittings	
Pipe	ASTM A53, Type S, extra strong, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI B16.11, Class 2000 or 3000; Bonney, Crane, Ladish, or Vogt.
Material Classification	CS-5
Extra Strong Steel With Forged Steel Socket Welded Fittings	
Pipe	ASTM A53, Type S, extra strong, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.
Material Classification	CS-6
Extra Strong Steel With Buttwelded Fittings	
Pipe	ASTM A53, Type E, extra strong, Grade B; or ASTM A106, of equivalent thickness.
Fittings	ANSI/ASME B16.9; extra strong.
Material Classification	CS-7
Standard Weight Steel With Threaded Cast Iron Fittings	

Pipe	ASTM A53, Type S, standard weight, Grade B; or ASTM A106, of equivalent thickness.
Fittings	Threaded type, ANSI/ASME B16.4, Class 125. When used for lime slurry piping service, fittings and flanges for disassembly and cleaning shall be provided only at the locations indicated on the drawings. Changes in alignment at other locations shall be accomplished by bending the pipe. All bends shall have a radius of at least 3 feet [0.9 m].
Material Classification	CS-8
Steel Hydraulic Tubing With Compression Fittings	
Tubing	ASTM A179, seamless, soft annealed, wall thickness as required.
Fittings	Steel, compression type, Crawford "Swagelok" or Parker Hannifin "CPI".
Material Classification	CS-9
PP Lined Steel Pipe	
Pipe and Lining	ASTM F429.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-10
PVD Lined Steel Pipe	
Pipe and Lining	ASTM F491.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-11
FEP Lined Steel Pipe	

Pipe and Lining	ASTM F546.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-12
PTFE Lined Steel Pipe	
Pipe and Lining	ASTM F423.
Fittings	A587, A106 Grade B, or A53.
Material Classification	CS-13
Glass Lined Steel Pipe	
Pipe	Standard weight steel pipe with flanged ends and Ceramic Coating "Non-Stick Glass Lining" or Vitco "SG-14 Glass Lined Pipe".
Fittings	Ductile iron, as specified in Master Specification Section 15061, Ductile Iron Pipe, with Ceramic Coating "Non-Stick Glass Lining" or Vitco "SG-14 Glass Lined Pipe".
Material Classification	CS-14
Double-Wall Secondary Containment Pipe	Perma Pipe/Ricwil Type "Ultra FS".
Carrier Pipe	Black steel pipe, ASTM A53, Type S, Grade B, Schedule 80.
Containment Pipe	Black steel pipe, ASTM A53, Type S, Grade B, Schedule 40 with FRP filament wound outer covering bonded to steel containment pipe, minimum 0.100 inch [2.5 mm] thick.
Fittings	Factory prefabricated, of the same materials and thickness as the specified pipe.

Leak Detection	Stainless steel leak detection guide tube and stainless steel cable pull wire to allow pulling of the leak detection cable into the containment pipe, both during and after piping installation.

2.1.02 Accessory Materials. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Nipples	ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.
Unions (Malleable Iron)	Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.
Flanges	
For Standard Weight Pipe	ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.
For Extra Strong Pipe	
Chemical Gas Piping	ASTM A105, forged steel, tongue and groove flanged union type, with nonmetallic gasket; rated for a working pressure of 1,500 psi [10.3 MPa].
Digester Gas Piping	ANSI/ASME B16.5, Class 150, flat faced.
Other Services	ANSI/ASME B16.5, Class 300, raised face.
For Plastic Lined Pipe	Steel, forged or cast, diameter and drilling in accordance with ANSI/ASME B16.5, Class 150 or 300 as required.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch [3 to 10 mm] beyond outer face of the nut.

Flange Gaskets

For Aeration/Backwash Air Service	
Raised Face Flanges	Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch [1.5 mm] minimum thickness for plain finished surfaces, 3/32 inch [2 mm] minimum thickness for serrated surfaces, rated for 275°F [135°C] service; Garlock "IFG 5507".
Flat Faced Flanges	Premium Grade, EPDM, ring type, 1/8 inch (3 mm) thick, rated for 275°F (135°C) service; Garlock "8314".
For Boiler Exhaust Service	Garlock "Blue-Gard, Style 3000".
For Oil Service	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch (1.5 mm) minimum thickness for plain finished surfaces, 3/32 inch (2 mm) minimum thickness for serrated surfaces.
For Heating Water Service	Non-asbestos inorganic fiber with nitrile binder; dimensions to suit flange contact face, 1/16 inch (1.5 mm)minimum thickness for plain finished surfaces, 3/32 inch (2 mm) minimum thickness for serrated surfaces; Garlock "IFG 5500".
For Water Service	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch (3 mm) thick.
For Other Services	
Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch (1.5 mm) minimum thickness for plain finished surfaces, 3/32 inch (2 mm) minimum thickness for serrated surfaces.

Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non- asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch +/- 0.005 inch (2.4 mm +/- 0.13 mm).
Grooved Couplings	
Rigid	AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
Standard	AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 77".
Mechanical Couplings	Dresser "Style 38" or Smith-Blair "Type 411 Flexible Coupling"; without pipe stop.
Expansion Joints	Flexonics "Model H Expansion Compensators" for 3 inch (75 mm) or smaller; Flexonics "Free Flexing Expansion Joints" with flanged ends and stainless steel bellows for 4 inch (100 mm) or larger.
Material Classification	CS-11
Joining	Carrier pipe shall be joined by socket welding. Containment pipe shall be joined by split sleeve of the same diameter as containment pipe with minimum 60 mil (1.5 mm) thick polyethylene jacket.
End Seal	End seals shall be furnished at all terminal ends. The end seal shall be sealed to the containment pipe.
Leak Detection	Microprocessor based monitoring unit, for continuous monitoring by cable of a single line for water and hydrocarbon.
Control Panel	Modified NEMA Type 12 enclosure, with status and alarm data Model "PAL-AT20C". Power supply to the unit will

	be 120 volt, 1 phase, 60 Hz. Unit shall be UL listed with alarm horn and shall locate leaks and not depend on battery back-up functions. System conditions shall be stored in memory in the event of power failure and shall automatically resume monitoring without reset once power is available. Monitoring unit shall be able to differentiate between water left in pipe during installation and an actual growing leak. Panel shall also be able to detect a break in sensor cable and its location.
Cable	Cable shall be located in the interstitial space between the carrier and containment pipe, shall detect both water and hydrocarbon, and shall be capable of being dried in place without being replaced after exposure to any fluid Type "AGW-Gold". Coaxial cable shall interface monitoring control panel with sensor cable by utilizing waterproof junction box for protecting connection.

2.1.03 Coatings and Linings. Standard weight steel pipe in buried locations shall have exterior surfaces protected with a shop applied plastic coating.

Extra strong steel pipe in buried locations shall have exterior surfaces protected with a shop applied plastic coating, a shop applied tape wrap, or will be coated by others in the field.

All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils (1.5 mm).

Coatings and linings shall be as indicated.

External Coatings

Plastic	Chevron Chemical Co. "Plexco Plexguard Coating" or Encoat/Lukens "Encoat Extruded Coating". The

	products of other manufacturers will not be acceptable.
Tape Wrap	ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils (760 μm); Protecto Wrap "200" or Tapecoat "CT".
Internal Linings	
PP Lining	ASTM F492.
PVDF Lining	ASTM F491.
FEP Lining	ASTM F546.
PTFE Lining	ASTM F423.
Glass Lining	Two-coat system applied over blast-cleaned surface; ground and finish coats separately fired; finished lining thickness at least 8 mils (200 μm), Mohs' Hardness 5 to 6, density 2500 to 3000 kg/m^3 as determined by ASTM D792.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation .

3.2 LEAKAGE AND PRESSURE TESTS. After installation, steel piping shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All steel piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15066

FIBERGLASS REINFORCED PLASTIC PIPE

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installation of low pressure fiberglass reinforced plastic pipe for exhaust air systems as indicated in the Contract Documents. Piping shall furnished complete with all fittings, transitions, jointing materials, expansion joints, and other necessary appurtenances.

Pipe supports are covered in Master Specification Section 15140, Pipe Supports. Anchors are covered in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

Pipe trenching, bedding, and backfill are covered in Master Specification Section 02221, Trenching, Backfilling, and Compacting.

1.2 GENERAL.

1.2.01 Coordination. Contractor shall verify that each component of the system furnished is compatible with all other parts of the system, that all piping and materials are appropriate for the expected services, and that all devices necessary for a properly functioning system have been provided.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.2.03 Pipe Identification. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data and catalog cuts, and shop assembled layout drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications shall include, but shall not be limited to, the following:

Pipe

Manufacturer’s name.

Brand designation.

Type of resin.

Pressure, vacuum, and temperature rating of pipe.

Certification of compliance with referenced standards.

Layouts and dimensions of subassemblies to be shipped.

Where the pipe sizes needed for the project are larger than the named manufacturer's standard pipe sizes, the following information shall be submitted for the pipe and fittings that are being provided:

Manufacturer's name.

Certified statement that covers construction and test methods.

Material sources.

Material types.

Average reinforced wall thickness for each pipe size.

Minimum reinforced wall thickness for each pipe size.

Average outside diameter for each pipe size.

Liner material.

Nominal liner thickness for each pipe size.

Expansion Joints

Name of manufacturer.

Type and model.

Materials of construction.

Force required for expansion and contraction.

Contractor shall submit procedures and results of all shop and field testing.

1.4 <u>QUALITY ASSURANCE</u>.

1.4.01 <u>Manufacturer's Field Services</u>. When indicated in the Contract Documents, the pipe manufacturer shall provide hands-on training for the installation contractor's employees in the proper assembly of butt joints. The pipe manufacturer's representative shall be on-site for at least one 8-hour day, during which they shall observe the assembly of at least three butt joints. The pipe manufacturer shall provide hands-on training for the installation contractor's employees in the proper assembly of butt joints. The pipe manufacturer shall submit written certification that the installation contractor's employees have satisfactorily completed all training and instruction and can perform the jointing required for this project in accordance with the pipe manufacturer's recommendations and as specified herein. All field butt joints shall be made by representatives of the pipe manufacturer or by employees of the installation contractor who have been trained and certified by the pipe manufacturer.

All fitters who fabricate and install piping with butt joints shall be qualified for this project. Training and qualification shall be provided by an authorized representative of the pipe manufacturer. Qualified fitters shall carry and have visible at all times a certificate of qualification issued by the pipe manufacturer. Contractor shall arrange the qualifying training.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Pipe and fittings shall be properly supported to avoid damage caused by flexural strains. Pipe and fittings shall not be thrown or dropped.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Fiberglass reinforced pipe will be used in the service conditions as indicated in the Contract Documents.

Pipe and appurtenances used in ventilation exhaust air or odor control systems will be continuously exposed to a humid environment containing hydrogen sulfide gas. Pipe and appurtenances used in emergency gas treatment exhaust systems will be exposed to chlorine gas.

2.2 DESIGN REQUIREMENTS.

2.2.01 Minimum Pipe Wall Stiffness. The minimum pipe wall stiffness, at 5 percent deflection, determined in accordance with ASTM D2412 and Section 3 of AWWA C950, shall be not less than the following:

Nominal Pipe Diameter		Pipe Stiffness	
inches	(mm)	psi	(kPa)
1-8	(25-200)	36	(250)

10	(250)	18	(125)
12-16	(300-400)	9	(62)
18 and larger, buried	(450 and larger, buried)	10 or greater as required	(70)
18 and larger, other locations	(450 and larger, other locations)	5	(35)

2.2.02 Temperature. All pipe, fittings, and appurtenances shall be suitable for the temperature conditions as indicated in the Contract Documents.

2.2 ACCEPTABLE MANUFACTURERS. The fiberglass reinforced plastic pipe, fittings and specials provided under this section shall be from the manufacturer as specified herein without exception.

2.3 MATERIALS.

Epoxy Pipe

Centrifugally Cast, 14 inches (350 mm) and smaller	ASTM D2997, RTRP-21C, centrifugally cast, reinforced epoxy resin pipe with 30 mil (750 µm) liner; Fibercast "Centricast III EP"; without exception.

Filament-Wound

16 inches (400 mm) and smaller	ASTM D2996, RTRP-11FE-111, RTRP-11FF-312, and RTRP-11FQ-311, with at least a 20 mil (500 µm) reinforced liner; Ameron "Bondstrand Series 2000"; Conley "Schedule 20E"; or Smith Fiberglass Products "Green Thread"; without exception.
18 through 20 inches (450 through 500 mm)	ASTM D2310, RTRP-11FQ, with at least a 20 mil (500 µm) reinforced liner; Conley "Schedule 20E"; without exception.

Vinyl Ester Pipe

16 inches (400 mm) and smaller	ASTM D2996, RTRP-12ED-101, RTRP-12EF-311, RTRP-12EQ-311, or RTRP-12EU-311, with vinyl ester resin and at least a 20 mil (500 µm) reinforced liner;

	Ameron "Bondstrand Series 5000"; Conley "Schedule 20V"; Fibercast "F-Chem 1222" or "F-Chem-V"; or Smith Fiberglass Products "Poly Thread"; without exception.
18 inches (450 mm) and larger	ASTM D2310, RTRP-12ED, -11EQ, or -12EU, with vinyl ester resin and at least a 20 mil (500 µm) reinforced liner; Ameron "Bondstran Series 5000"; Conley "Schedule 20V"; Fibercast "F-Chem-V"; or Smith Fiberglass Products "Big Thread LVV"; without exception.
Fittings	Manufacturer's standard, glass fiber reinforced, compatible with the pipe and with chemical resistance equal to or greater than the pipe.
Flanges	ASTM D3982
Flange Bolts or Studs	ASTM A307, Grade B, galvanized or ASTM F593, Type 304 stainless steel as required; length such that, after installation, bolts will project 1/8 to 3/8 inch (3 to 9 mm) beyond the outer face of the nut.
Nuts	ASTM A307, Grade B, galvanized or ASTM F594, Type 304 stainless steel.
Flat Washers	ANSI B18.22.1, plain, galvanized or ANSI B18.22.1, Type 304 stainless steel.
Flange Gaskets	Full face, ASTM D2240, Type A durometer 50-70; at least 1/8 inch (3 mm) thick, neoprene, viton, or nitrile material.
Bell-and-Spigot Joints	Matched tapered bell-and-spigot ends bonded with adhesive.
Butt Joints	Butt and wrap, resin bonded, PS-15, with pressure rating equal to the pipe.
Expansion Joints	As specified herein.
Adhesive	Pipe manufacturer's standard.

All pipe, fittings and appurtenances shall contain ultraviolet (UV) inhibitors. Resins used in the piping system laminates shall have a flame spread rating of 25 or less when tested in accordance with ASTM E84.

2.4 FABRICATION.

2.4.01 Jointing Method. Unless otherwise specified, 14 inch (350 mm) and smaller pipe shall have coupled adhesive bonded joints. Sixteen inch (400 mm) and larger pipe shall have bell-and-spigot or butt joints. Shop fabricated assemblies should be provided to the maximum extent possible, to minimize the number of field joints.

Flanged joints shall be provided at each damper and item of equipment to facilitate disassembly, at each change in material, and where indicated on the drawings. Bolts, nuts, washers, and gaskets shall be provided for all flanged connections in the piping system, including connections to equipment.

Field butt joints shall be located at least 12 inches (300 mm) from any increasing or decreasing cross-section of pipe where the pipe to be jointed has the same diameter.

2.4.02 Butt Joints. Butt joints shall be provided in accordance with the manufacturer's recommendations and as specified herein. Twenty inch (500 mm) and larger pipe shall be overlaid both inside (when accessible) and outside. Eighteen inch (450 mm) and smaller pipe shall be overlaid on the outside only. The minimum width of the overlay shall be as specified in the following table. Inside overlaps shall be made to seal the joint but shall not be considered in meeting the strength requirements.

Pipe Size		Minimum Total Width of Overlay	
Inches	(mm)	Inches	(mm)
18-20	(450-500)	14	(350)
24-36	(600-900)	18	(450)
42-54	(1050-1350)	24	(600)
60-72	(1500-1825)	26	(650)

Finished joints shall be built up in successive layers, shall be as strong as the pieces being joined, and shall be as crevice-free as is commercially practicable, in accordance with ASTM D2563. The width of the first layer shall be at least 4 inches (100 mm). Successive layers shall be increased uniformly to provide the specified minimum total width of overlay which shall be centered on the joint. Crevices between jointed pieces shall be filled with resin, leaving a smooth inner surface. The interior of joints shall also be sealed by covering with not less than 0.1 inch (2 mm) of liner of the same material as the pipe.

2.4.03 Transitions. Fiberglass reinforced plastic transition sections shall be furnished for connecting round pipe to rectangular openings on equipment. Transitions shall have a pressure rating and wall stiffness equal to those of the pipe. Internal lining shall be of the same type of material and thickness as specified for the pipe. Transitions shall have flanged end connections compatible with the connecting pipe and equipment.

2.4.04 Expansion Joints. Expansion joints shall be furnished at the locations indicated on the drawings and at other locations required for proper pipe installation. Expansion joints shall be resistant to ultraviolet light and shall be suitable for the service conditions.

Expansion joints shall be slip-on or flange type. The slip-on type shall be sized to fit tightly on the outside circumference of the pipe and shall be secured in place by adjustable, corrosion-resistant band type clamps. Flange type expansion joints shall have split steel retaining rings and shall have diameter and drilling to match the pipe flanges.

Expansion joints shall be designed to compress 1 inch (25 mm) and to elongate 1 inch (25 mm) with a maximum force to cause movement of 100 lbs (445 N) or less. The joints shall also allow lateral deflections of up to 1 inch (25 mm).

PART 3 - EXECUTION

3.1 INSPECTION. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Any pipe that is damaged or shows evidence of contamination shall not be installed in the piping system.

3.2 PREPARATION.

3.2.01 Field Measurement. Pipe shall be cut to measurements taken at the site, not from the drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION. Pipe shall be installed as specified and as indicated on the drawings. All necessary provisions shall be taken in the fabrication and installation of piping to provide for expansion and contraction. Expansion joints shall be installed.

The piping shall be supported as indicated on the drawings and in accordance with the requirements of Master Specification Section 15140, Pipe Supports.

The inside of pipe, fittings, and transitions shall be smooth, clean, and free from blisters, when installed.

3.3.01 Pipe Sleeves. Piping passing through concrete or masonry shall be installed through sleeves installed before the concrete is placed or when masonry is laid.

3.3.02 Pipe Joints. Pipe joints shall be carefully and neatly made in accordance with the following specified requirements.

3.3.02.01 Adhesive Bonded Joints. All joint preparation, cutting, and jointing for adhesive bonded joints shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the recommended curing period.

3.3.02.02 Flanged Joints. Flange bolts shall be tightened sufficiently to slightly compress the gasket and make a good seal, but not so tight as to distort the flanges. A flat washer shall be installed under each nut and bolt head.

3.3.02.03 Butt Joints. Butt joints shall be made in accordance with the manufacturer's recommendations and as specified herein.

The inner surface shall be free of cracks and crazing, with a smooth finish, and with an average of not more than two pits per square foot (21 pits per square meter), provided the pits are less than 1/8 inch (3 mm) in diameter, not more than 1/32 inch (0.7 mm) deep, and covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits. Such surfaces may be reinforced with glass surfacing mat, synthetic fibers, or other suitable material.

3.3.03 Alignment. Piping installed below grade shall be laid to the lines and grades indicated on the drawings. Batter boards, laser beam equipment, or surveying instruments shall be used to maintain alignment and grade.

Batter boards, if used, shall be erected at intervals of not more than 25 feet (7 m). Batter boards shall be used to determine and check pipe subgrades. At least three batter boards shall be maintained in proper position at all times when trench grading is in progress.

If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.3.04 Laying Pipe. Pipe installed below grade shall be protected from lateral displacement by placing the specified pipe embedment material. Pipe shall not be laid in water or under unsuitable weather or trench conditions.

Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Engineer.

Whenever pipe laying is stopped, the open end of the pipe shall be closed with an end board closely fitting the end of the pipe, to keep sand and earth out of the pipe. The end board shall have several small holes near the center to permit water to enter the pipe and to prevent flotation in the event of flooding of the trench.

3.4 FIELD QUALITY CONTROL.

3.4.01 Butt Joint Procedure Training. When training isindicated in the Contract Documents , the pipe manufacturer shall submit written certification that the installation contractor's employees have satisfactorily completed all training and instruction and can perform the jointing required for this project in accordance with the pipe manufacturer's recommendations and as specified herein.

3.4.02 Field Testing. All necessary testing equipment and materials, including tools, appliances, and devices, shall be furnished by Contractor. All tests shall be made by and at the expense of Contractor and at such time as directed by Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to demonstrate compliance with specified requirements. Engineer shall be present during all testing. The piping system shall be tested at 0.75 psi (5 kPa) pressure with air for at least 1 hour, and shall not leak. All joints which are found to leak, by observation or during testing, shall be repaired by Contractor, and tests repeated.

Leakage may be determined by loss of pressure or other method acceptable to Engineer. All equipment or other accessories which would be damaged if subjected to the specified test pressure shall be disconnected, and ends of branch lines plugged or capped, as required, during the testing procedures.

End of Section

SECTION 15067

MISCELLANEOUS PLASTIC PIPE, TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous plastic pipe, tubing and accessories for the services as indicated in the Contract Documents. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all materials provided under this section.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but not be limited to, the following:

Chemical resistant waste pipe and fittings.

Expansion joints.

Flange gaskets.

FRP double wall pipe and fittings.

Gas pipe and fittings.

Pipe sleeves.

Polyethylene pipe and fittings.

Polypropylene pipe and fittings.

PVC pipe and fittings.

CPVC pipe and fittings.

PVDF pipe and fittings

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

Pipe, tubing, and fittings shall be stored between 40°F and 90°F (4°C and 32°C).

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Miscellaneous plastic pipe materials shall be for the services as indicated in Miscellaneous Plastic Pipe, Tubing and Accessories Schedule 15067-S01.

Material Classification	FRP-1
FRP Pipe	
Pipe	ASTM D2996, filament-wound, glass fiber reinforced, vinyl ester resin pipe with 20 mil (500 μm) reinforced resin-rich liner; Fibercast "F-Chem 1222" or Smith Fiberglass Products "Poly Thread".
Fittings and Flanges	Glass fiber reinforced, compatible with the specified pipe, with ratings and chemical resistance equal to or greater than the specified pipe.

Material Classification	PVC-1
Schedule 40 PVC Pipe With Solvent Welded Joints	
Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Fittings	ASTM D2466, Cell Classification 12454-B, bearing NSF seal.
Material Classification	PVC-2
Schedule 80 PVC Pipe With Solvent Welded Joints	
Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Fittings	ASTM D2467, Cell Classification 12454-B, bearing NSF seal.
	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld.
	When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.
Material Classification	PVC-3
Schedule 80 PVC Pipe With Threaded Joints	
Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Fittings	ASTM D2464, Cell Classification 12454-B, bearing NSF seal.

Material Classification	PVC-4
PVC DWV Pipe (Single Wall) With Solvent Welded Joints	
Pipe	ASTM D1785, cell classification 12454-B, bearing NSF seal.
Fittings	ASTM D2665 and ASTM D3311, cell classification 12454-B, bearing NSF seal.
Material Classification	PVC-5
PVC DWV Pipe (Double Wall Containment) With Solvent Welded Joints	
Pipe	Sloan "GSR Contain-it"; with manufacturer's standard spacers, fittings, and suitable chemical service solvent or equal.
Fittings	ASTM D2665 and ASTM D3311, cell classification 12454-B, bearing NSF seal.
Material Classification	PVC-6
PVC Underdrain Pipe and Fittings	
Pipe	ASTM F758, solid or perforated wall, as specified herein, Cell Classification 12454-C or 12364-C, Type PS 46, with solvent welded or elastomeric gasket joints, as specified herein.
Fittings	ASTM D3034, Cell Classification 12454-B or 12454-C, wall thickness SDR 35, with solvent welded or elastomeric gasket joints, as specified herein.
Material Classification	PVC-7

Double-Contained Chemical Feed Pipe	
System	Prefabricated system consisting of primary pipe supported within a Schedule 80 PVC secondary containment housing. Primary pipe material and fittings shall be as specified for single-contained piping for the respective chemical.
Containment Pipe	ASTM D1785, Cell Classification 12454-B, bearing NSF seal.
Interstitial Supporting Devices	Polypropylene spider clips or C-type, within the secondary containment pipe.
Material Classification	CPVC-1
Schedule 80 CPVC Pipe With Solvent Welded Joints	
Pipe	ASTM F441, Schedule 80, Cell Classification 23447-B, bearing NSF seal.
Fittings	ASTM F439, Cell Classification 23447-B, bearing NSF seal.
	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld.
	When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.
Material Classification	PE-1

PE Pipe (4 inch [100 mm] and smaller) With Socket Fusion Fittings	
Pipe	ASTM D3350, Cell Classification PE345434C.
	ASTM D2513, IPS, SDR11; Chevron Chemical Co. "Plexco Yellow-stripe PE3408 Gas Pipe".
Fittings	ASTM D1248, Type III, Class C, Grade P34.
	ASTM D2683, socket type, with wall thickness same as for pipe.
Material Classification	PE-2
PE Pipe (6 inch [150 mm] and larger) With Butt Fusion Fittings	
Pipe	ASTM D3350, Cell Classification PE345434C.
	ASTM D2513, IPS, SDR11; Chevron Chemical Co. "Plexco Yellow-stripe PE3408 Gas Pipe".
Fittings	ASTM D1248, Type III, Class C, Grade P34.
	ASTM D3261, butt heat fusion type, with wall thickness same as for pipe.
Material Classification	PE-3
PE Tubing With Compression Fittings	
Tubing	1/8 through 5/8 inch [3 through 16 mm] OD, 1/16 inch [1 mm] wall thickness, 130°F [54°C] max operating temperature.

Fittings	As recommended by the chlorine feed system manufacturer.
Material Classification	PE-4
PE Pipe	
Pipe	ASTM D3350, Cell Classification PE334434C.
	ASTM F714, DR as specified herein, Phillips "Driscopipe 1000", "Driscopipe 8600", or Plexco "PE 3408", as specified herein.
Fittings	Molded or manufactured from pipe; cell classification of material and pressure rating same as for pipe.
Material Classification	PE-5
Corrugated PE Drainage Tubing and Fittings	AASHTO M252 and ASTM F405, with solid or slotted wall, as specified herein.
Material Classification	PE-6
Polyethylene Tubing and Fittings	1/8 through 3/4 inch [3 through 19 mm] OD, 1/16-inch wall thickness, 130°F maximum operating temperature with compression fittings.
Material Classification	PP-1
Schedule 40 PP Pipe With Socket Fusion Fittings	
Pipe	ASTM D4101, Class 1, virgin, unpigmented homopolymer without additives or UV stabilizer; Enfield or Orion.
	Dimensions in accordance with ASTM D2447.

Fittings	Same material as pipe. Socket fusion type compatible with the pipe; Enfield or Orion.
Material Classification	PP-2
PP DWV Pipe With Heat Fused Joints	
Pipe	Schedule 40, ASTM D4101. Orion "Brownline" for standard type or "Blueline" for flame retardant type, Enfield, or R&G Sloan.
Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard heat fused socket joint. Solvent weld joints not permitted.
Material Classification	PP-3
PP DWV Pipe With Mechanical Joints	
Pipe	Schedule 40, ASTM D4101. Orion "Brownline" for standard type or "Blueline" for flame retardant type, Enfield, or R&G Sloan.
Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard.
Material Classification	PVDF-1
PVDF DWV Pipe With Heat Fused Joints	
Pipe	Schedule 40, UL 94-VO, non-combustible. Orion or equal.

Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard heat fused socket joint. Solvent weld joints not permitted.
Material Classification	PVDF-2
PVDF DWV Pipe With Mechanical Joints	
Pipe	Schedule 40, UL 94-VO, non-combustible. Orion or equal.
Fittings	Schedule 40, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
Joints	Manufacturers' standard.
Material Classification	PVDF-3
Schedule 80 PVDF With Socket Type Heat Fusion Welded Joints	
Pipe	ASTM D3222 for Type 1 homopolymers. Manufactured to wall thicknesses specified in ASTM D1785 for Schedule 80 Pipe.
Fittings	ASTM D2467.
	Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a heat fusion weld.
	When acceptable to the Engineer, threaded joints may be used instead of solvent welded joints for the purpose of facilitating disassembly. The use of threaded joints in this system shall be held to a minimum.

Material Classification	PVDF-4
Schedule 80 PVDF With Threaded Joints	
Pipe	ASTM D3222 for Type 1 homopolymers manufactured to wall thicknesses specified in ASTM D1785 for Schedule 80 Pipe.
Fittings	ASTM D2464.
Material Classification	RPT-1
Reinforced Plastic Tubing	Wire reinforced PVC hose; Cobon Plastics Corp. "Cobovin Type S" or NewAge Industries Inc. "Vardex".

2.1.02 Accessory Materials. Accessory materials for the miscellaneous plastic pipe systems shall be as indicated.

Material Classification	FRP-1
Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ASTM A307, Grade B, galvanized, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
Flat Washers	ANSI B18.22.1, plain, galvanized.
Flange Gaskets	Full face, 1/8 inch (3 mm) thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.
Material Classification	PVC-1 through PVC-7, and PVDF-1 through PVDF-4
Flanges	Diameter and drilling shall conform to

	ANSI/ASME B16.5, Class 150.
	Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
	Stainless steel for DWV and sulfuric acid feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain.
	Stainless steel for DWV and sulfuric acid feed systems, galvanized steel for all other systems.
Flange Gaskets	Full face, 1/8 inch (3 mm) thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.
Material Classification	CPVC-1
Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut.
	Stainless steel for chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain.
	Stainless steel for chemical feed systems, galvanized steel for all other systems.

Flange Gaskets	Full face, 1/8 inch (3 mm) thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.
Material Classification	PE-1 through PE-6
Flanges	Schedule 80 PVC; diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ANSI B18.2.1, ASTM A193, AISI Type 304, heavy hex head, length such that after installation the bolts will project 1/8 to 3/8 inch (3 to 10 mm) beyond outer face of the nut. ASTM A194, AISI Type, ANSI/ASME B18.2.2, heavy hex pattern.
Fittings and Flange Adapters	Molded or manufactured from the pipe; cell classification of material and pressure rating same as for pipe.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation.

3.2 LEAKAGE AND PRESSURE TESTS. After installation, plastic piping shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All plastic piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

3.3 SCHEDULE. See Miscellaneous Plastic Pipe, Tubing and Accessories Schedule 15067-S01.

End of Section

SECTION 15069

CAST IRON SOIL PIPE AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of cast iron soil pipe and accessories for the services as indicated in the Contract Documents. Cast iron soil pipe shall be furnished complete with all fittings and other accessories specified herein.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but shall not be limited to, the following:

Gaskets.

Sleeves.

Name of Manufacturer.

Type and Model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.3 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Cast iron soil pipe materials shall be as indicated.

Material Classification	CI - 1
Bell and Spigot	
Pipe and Fittings	Bell and spigot type, ASTM A74.
Jointing Material	Rubber gaskets, ASTM C564.
Material Classification	CI - 2
Hubless	
Pipe and Fittings	Hubless type, CIPSI 301.
Jointing Material	Rubber sleeves, CIPSI 310.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation.
3.2 LEAKAGE AND PRESSURE TESTS. After installation, cast iron soil pipe shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All cast iron soil piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15070

COPPER TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of copper tubing and accessories for the services as indicated in the Contract Documents. Copper tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS.

1.2.01 Drawings and Data. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Items requiring submittals shall include, but shall not be limited to, the following:

Expansion joints.

Flange gaskets.

Insulating (dielectric) couplings, threaded and flanged.

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Pressure and temperature rating.

Manufacturer shall submit certification that each item furnished is in accordance with the reference standards.

Contractor shall submit procedures and results of all shop and field testing.

1.3 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS.

2.1.01 Pipe Materials. Copper tubing materials shall be as indicated.

Material Classification	CU-1
Water Tubing With Flared Fittings	
Tubing	Soft annealed copper tubing, ASTM B88, Type K.
Fittings	Flared, ANSI/ASME B16.26.
Material Classification	CU-2
Water Tubing With Flanged Fittings	
Tubing	Hard drawn copper tubing, ASTM B88, Type L.
Fittings	Flanges, ANSI B16.24, Class 150, cast bronze, brazed joint.
Material Classification	CU-3
Water Tubing With Solder Joints	
Tubing	Hard drawn copper tubing, ASTM B88, Type L.
Fittings	Solder joint, ANSI B16.18, or ANSI/ASME B16.22.
Material Classification	CU-4
Chemical Feed Tubing With Union Fittings	
Tubing	Soft annealed copper tubing, ASTM B88, Type K, cadmium plated for chlorine services.

Fittings	Union type with nonmetallic gasket or chemical lead alloy gasket containing 2-4 percent antimony. Fittings will be brazed to tubing.
Material Classification	CU-5
Instrument Tubing With Compression Fittings	
Tubing	Soft annealed copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280.
Fittings	Compression type, brass, Crawford "Swagelok" or Parker Hannifin "CPI".
Material Classification	CU-6
ACR Tubing With Brazed Fittings	
Tubing	Hard drawn ACR copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280.
Fittings	Brazed.
Material Classification	CU-7
Copper Hydraulic Tubing With Compression Fittings	
Tubing	ASTM B75, seamless, soft annealed, wall thickness as specified herein.
Fittings	Compression type, brass, Crawford "Swagelok" or Parker Hannifin "CPI".

2.1.02 Accessory Materials. Accessory materials for the copper tubing systems shall be as indicated.

Insulating Fittings

Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene-lined, zinc plated; Perfection Corp. "Clearflow Fittings".
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch (3 to 10 mm beyond outer face of the nut.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch (3 mm) thick.
Expansion Joints	Tempflex "Model HB Expansion Compensators" with copper tube ends.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories - Installation.

3.2 LEAKAGE AND PRESSURE TESTS. After installation, copper tubing shall be subjected to a leakage and pressure test.

3.2.01 Leakage. All copper tubing shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.2.02 Pressure and Leakage Test. Pressure and leakage testing shall be in accordance with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

End of Section

SECTION 15080

ROLLER GATES

PART 1 – GENERAL

1.1 SCOPE**.** This section includes the furnishing, installation, and testing of rising or non-rising stem sluice gates with or without motor operated floor stands and wall thimbles.

The gates shall conform to the current edition of AWWA Standard C-501 except as otherwise specified in the Contract Documents.

The gates shall be designed for indoor or outdoor operation in hazardous or non-hazardous locations in sewage, as scheduled on the Drawings, and may or may not be designed for modulating service.

If the gates shall be equipped with control equipment suitable for remote operation from a remote control panel and/or a remote computer signal, refer to the Master Specifications in Divisions 16 and 17 for installation and connection of controls.

1.2 GENERAL.

1.2.01 Governing Standards.

ANSI A 21.6 (AWWA C106) – Specification for Cast Iron Pipe Centrifugally Cast in Metal Molds for Water and Other Liquids.

ANSI A 21.8 (AWWA C108) Specification for Cast Iron Pipe Centrifugally Cast in Sand Molds for Water and other Liquids.

ANSI A 21.51 (AWWA C151), Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds for Water or Other Liquids.

ANSI B 1.1- Specification for Unified Screw Threads," Course Thread Series, Class 2 Fit, for Tapped Holes.

ANSI B 1.1, "Screw Threads," Course Thread Series, Class 2.

ANSI B 16.1, "Cast Iron Pipe Flanges and Flanged Fittings,' Class 125.

ANSI B 16.2 – Specification for Cast Iron Pipe Flanges and Flanged Fittings," Class 250.

ASTM A126 (American Society for Testing and Materials) – Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, “Class B”.

ASTM A167 – Specification for Corrosion-Resisting Chromium-Nickel Steel Plate, Sheet and Strips. Grade 3

ASTM A276 – Specification for Cold Finished, Stainless, and Heat Resisting Steel Bars. Type 316.

ASTM A536 – Specification for Ductile Iron Castings,” Grade 70-50-05.

ASTM A653 - Specification for Steel Sheet, Zinc – Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.”
DWSD Specification S-102-1, “Cast Iron Pipe,” revised October 1973.

ASTM B98 – Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

ASTM B584 – Specification for Copper Alloy Sand Castings for General Applications.

ASTM B21, “Naval Brass Rod, Bar, and Shapes.”

ASTM B144, “High Leaded Tin-Bronze Sand Castings,” Alloy 3A.

ASTM F104, (F112600M7) – Classification System for Nonmetallic Gasket Materials.

AWWA C501 – Cast Iron Sluice Gates.

DWSD Specification S-658-2, “Ductile Iron Pipe, January 1973.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit detailed Shop Drawings showing sluice gate installation dimensions and details and materials of construction of all sluice gate components as called for in Master Specification Section 1180, Submittals. Complete wiring and control diagrams shall be submitted per Master Specification Division 16000, Electrical and Division 12000, Instrumentation and Controls.

1.4 DELIVERY STORAGE AND HANDLING. Sluice gates are provided with locking plates to hold the disc firmly in place in the guides during shipping and installation. Gates can be lifted by a chain or sling through the stem hole in the disc only when locking plates are in place. When lifting gates, take special care to protect machined surfaces and wedges. Locking plates must be removed before opening gate.

Equipment should be stored in a clean, dry area on planks or timbers over an even surface to keep them off the ground and to prevent distortion. Equipment should also be covered to protect seat facings and other machined surfaces from foreign matter. Sluice gates should not be stacked more than three high, and then, only with heavy timber blocking placed between the gates to prevent damage to gates.

To prevent bending when lifting, handling and storing, stems should be supported over their full length. The threaded portion of the stem is protected by a heavy fiber cover, which should not be removed until the stem is ready for installation. Couplings and thrust nuts are shipped in place on the stems and should be removed prior to installation. Stop collars are normally shipped in a bag or box accompanying the floor stands. Operating mechanisms should be handled and treated as precision machinery and protected accordingly.

1.5 WARRANTY. The manufacturer shall furnish to the Owner the warranty as specified in the Master Specification Section 01170, Warranties and Bonds, for the equipment and materials installed under this section of the specifications. Upon receipt of notice from the Owner of failure of any part of the guaranteed materials or equipment during the warranty period, new replacement part or parts shall be furnished and installed promptly by the Contractor at no additional cost to the Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Sluice gates shall be as manufactured by Rodney Hunt Company, Hydro Gate Corporation, Watermain Industries or equal.

2.2 MATERIALS.

2.2.01 Sluice Gate. Sluice gates shall be ductile iron, bronze mounted heavy duty, flanged frame, with or without flush bottom closure as scheduled on the Drawings. Each gate shall be equipped with an adjustable side and top wedge system and designed for a maximum seating or unseating head of 40 (12.2 m) feet of water unless otherwise scheduled on the Drawings.

2.2.02 Wall Thimble. A separate ductile iron wall thimble, Type F, 18 inches (45.7 cm) in depth shall be furnished by the manufacturer for each sluice gate. Thimbles shall be cast in one piece with integral flanged wall ribs and grout holes and shall be of such dimensions and design as approved by the Engineer.

Wall thickness shall not be less than AWWA, Class D; and the flange thickness shall be not less than ANSI, Class 125. The thimble flange faces shall be faced, drilled, and tapped for flange studs as required.

2.2.03 Stem. The top of the stem shall project at least 1 inch (2.54cm) above the operating lift nut when gate is in closed position. The stem diameter shall be selected to limit the l/r ratio between supports to no more than 120, And the Stem couplings, if required, shall be made of bronze and shall be internally threaded and provided with pins of the required size. Note that, the stem shall be made of Type 316 stainless steel and the operating threads shall be Acme Standard or equal accurately rolled or cut in a lathe.

2.2.04 Guides. The sluice gate guides shall be made of ductile iron and shall be of such length that at least one-half the height of the leaf shall be supported by the guides when the gate is in the fully open position. The extension of the gate guides shall be securely anchored to the concrete by means of Type 316 stainless steel anchor bolts, nuts, and pipe spacers. The anchor bolts shall be embedded in the concrete not less than 8 inches (20.3 cm), and the guide slots shall be machined and lined for the full length of the guides with bronze linings. The guide linings shall provide not more than 1/6 inch (1.6 mm) clearance with the tongues on the sides of the leaf. In the case, where the guides are not integrally cast, they shall be doweled and bolted to the gate frame, and the brackets in contact with the wedges on the leaf shall be heavily ribbed to withstand the thrust due to water pressure and wedging action of the leaf wedges, and shall be machined and fitted with bronze wedge facings, which shall be machined on all bearing surfaces to make accurate contact with the wedges.

2.2.05 Stem Guides. Stem guides if required shall be split bronze bushings.
Their brackets shall be made of cast iron with heavily ribbed sections and shall be mounted to the wall with stainless steel anchor bolts and nuts. The distance from the wall to the centerline of the stem shall be readily adjustable. The bushings shall be mounted to the bracket and doweled in such a manner that the stem may be removed without disturbing the alignment of the guide bracket and bushings, where all bolts and nuts shall be made of stainless steel 316, and the bracket and anchor bolts shall be of sufficient strength to withstand all possible stress from operation of the gate.

2.2.06 Wedges. The gate leaves shall be equipped with adjustable bronze wedges of approved design to provide uniform distribution of the seating and unseating pressure. Each leaf shall have machined pads for the wedges. The number, arrangement, location, and method of adjustment of the wedges shall ensure that any leakage occurring shall be 0.1 gallon per minute per linear foot of the surface perimeter. The wedges shall be held in place and adjusted by means of bronze studs, nuts, and washers and shall be machined on all bearing surfaces and shall make accurate contact with the wedge seats attached to the frame.

2.2.07 Gaskets. All gaskets necessary for a complete installation shall be furnished and shall be one piece, where applicable, and shall be 1/16 of an inch (1.6 mm) full face, 3000, manufactured by Garlock or Anchor Packing Superheat 490C, or equal.

2.2.08 Painting. All iron and steel surfaces except machined surfaces, submerged or non-submerged, shall be surface prepared and shop painted as defined in Master Specification Section 09900, Painting, Paragraph 2.2 Materials using National Sanitation Foundation Standard 61 certified products.

2.2.09 Gray and Ductile Gray Cast Iron. All cast iron castings shall be made from cast iron which shall be in conformity with the current ASTM A126, Class B (31,000 psi (213,714 kPa) minimum tensile strength) or equal, and shall be clean, smooth, free from blow or sand holes, porosity, cold shuts, cracks, or other physical defects and shall be tough and close grained. All ductile iron casting shall comply in similar fashion with ASTM A536. Note that, plugging, patching, or welding of defective castings will not be permitted except that minor repairs may be made with prior approval of the Engineer.

2.2.10 Steel. Steel used in the manufacture of the sluice gate and its appurtenances shall be of the best quality open hearth or electric furnace steel having an ultimate tensile strength of not less than 36,000 psi (248,184 kPa), and shall be hot-dipped galvanized after fabrication.

2.2.11 Stainless Steel. The stainless steel for operating stem, bolts, nuts and studs shall be in conformity with the current ASTM A276, Type 316, or approved equal.

2.2.12 Bronze. All bronze parts shall be of uniform composition and quality, shall be free from surface cracks or other defects, and shall conform accurately to the required dimensions, where all defective parts and parts not in conformity with these specifications shall be rejected. The bronze for the stem nut, couplings, thrust nuts, wedges, wedge seats, and gate seats shall be in conformity with the current ASTM B147, Alloy 8B, or approved equal. Seat facing applied by forging shall be in conformity with the current ASTM B21.The bronze for stem guide bushings shall be in conformity with the current ASTM B144, Alloy 3A, or approved equal. Bronze bolts, studs, nuts, anchor bolts, and coupling pins shall be in conformity with the current ASTM B98.

2.2.13 Crank and Hand Wheel – Operated Floor Stands. The geared floor stand shall have a weatherproof, housing, with a bronze operating nut, mounted on a high strength pedestal. Tapered roller bearings shall be located above and below bronze operating nut to support the output thrust of the floor stand. The gearing shall be accurately cut and of proper design to support the load conditions without undue stress. The shaft shall be mounted to provide low friction operation and to resist axial and radial thrusts. Mechanical seals shall be provided around the operating nut and the pinion shaft to prevent lubrication from leaving the unit and moisture from entering the sealed housing. The reduction gear case shall be precision machined and equipped with roller or needle bearings sealed about the reduction shafts. Lubrication fittings shall be provided for all bearings. Crank operated floor stands will be selected so that no more than 40 lb (18.12 Kg) effort shall be needed on the crank to open or close the sluice gate or slide gate. And gear ratio shall be identified by drawings or Engineer. Crank handles and handwheels shall be worked with the direction of rotation to open the valve (usually counterclockwise). Each crank handle or handwheel shall have cast thereon the word “Open” and an arrow indicating the direction to open. The number of turns required to close the gate shall be worked in an appropriate and visible location.

2.2.14 Electric Operators. Electric operators shall be per Master Specification Section 15180, Valve and Gate Actuators.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Installation of the sluice gates, guides, stem supports, and operators shall be in accordance with the manufacturer’s detailed instructions.
Prior to the pouring of concrete for the wall containing the sluice gate, the wall thimble shall be accurately placed in the wall forms in accordance with the manufacturer’s instruction. Each wall thimble shall be internally braced and bolted to the forms to prevent any distortion during installation operations. Each operator shall be accurately set and plumbed and shall be in proper alignment with the gate and stem before it is installed in place. Operating stems shall be installed in proper alignment and shall not bind in the lift nut or stem guides.

3.2 FIELD QUALITY CONTROL. If inspection or tests disclose defects or non-compliance with the provisions of these specifications, such defects or improperly installed work shall be replaced or adjusted and the tests repeated until compliance with these specifications is obtained.

3.2.01 Field Testing. Following the completion of each roller gate installation, the gate shall be operated through at least two complete open-close cycles, the gate shall be readjusted and re-operated as necessary, and left in a condition acceptable to the Engineer. A field leakage test shall be performed by the Contractor after installation of the gates. Maximum permissible leakage shall be in accordance with AWWA C560. The manufacturer shall be notified of the test in sufficient time to enable him to have a representative present at the test site. After all adjustments have been made and the mechanisms properly lubricated, each gate slide shall be operated through one complete cycle as a final check on proper operation before starting the leakage test.

Complete operation and maintenance requirements shall be including complete manufacturers product data in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals.

3.2.02 Inspection. A representative of the manufacturer shall be present during installation and shall instruct the Contractor's personnel in proper installation procedures and supervise the installation. He shall approve the installation and witness the test.

3.3 MAINTENANCE. Complete training, operation and maintenance requirements shall be provided including complete manufacturers product data in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals. The manufacturer's representative shall instruct the Owner's personnel in the proper operation and maintenance of the Sluice Gates.

End of Section

SECTION 15082

CAST-IRON SLIDE GATES

PART 1 – GENERAL

1.1 SCOPE. This section includes the furnishing, installation, and testing of rising stem slide gates with or without motor operated floor stands and wall thimbles.

The gates shall conform to the current edition of AWWA Standard C-560 except as otherwise specified in the Contract Documents.

The gates shall be designed for indoor or outdoor operation in hazardous or non-hazardous locations in sewage, as scheduled on the Drawings, and may or may not be designed for modulating service.

If the gates shall be equipped with control equipment suitable for remote operation, Contractor shall conform to the Master Specifications, Divisions 16, Electrical and Division 17, Instrumentation and Controls for installation and connection of the control systems.

1.2 GENERAL.

1.2.01 Governing Standards.

AWWA – American Water Works Associtaion: C560 - Cast-Iron Slide Gates

AWWA/ANSI – American National Standard Institute: C540 - Power Actuating Devices for Valves and Slide Gates

AISI – American Iron and Steel Institute: 1117 - Standard for Resulfured Carbon Steel

AISI – 4140 - Standard for Alloy Steel

AISI – 8620 - Standard for Alloy Steel

ANSI/ASME – American Society of Mechanical Engineers: B16.1 - Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

ANSI/ASME: B46.1 - Standard for Surface Textures (Surface Roughness, Waviness, and Lay)

ANSI/ASTM – American Society for Testing and Materials: D471 - Standard Test Method for Rubber Property - Effect of Liquids

ASTM – A36/A36M - Standard Specification for Carbon Structural Steel

ASTM – A48 - Standard Specifications for Gray Iron Castings

ASTM – A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM – A276 - Standard Specification for Stainless Steel Bars and Shapes

ASTM – A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars, Hot-Rolled or Cold-Finished

ASTM – B21 - Standard Specification for Naval Brass Rod, Bar, and Shapes

ASTM – B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes

ASTM – B138 - Standard Specification for Manganese Bronze Rod, Bar, and Shapes

ASTM – B139/B139M - Standard Specification for Phosphor Bronze Rod, Bar, and Shapes

ASTM – B148 - Standard Specification for Aluminum-Bronze Sand Castings

ASTM – B505 - Standard Specification for Copper-Base Alloy Continuous Castings

ASTM – B584 - Standard Specification for Copper Alloy Sand Castings for General Applications

ASTM – D1149 - Standard Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber

ASTM – D2000 - Standard Classification System for Rubber Products in Automotive Applications

ASTM – F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

ASTM – F594 - Standard Specification for Stainless Steel Nuts

CDA Copper Alloy Numbers (Note: CA precedes alloy numbers defined by CDA)

SSPC – SP6 - Commercial Blast Cleaning

SSPC – SP10 - Near-White Blast Cleaning

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Submit detailed Shop Drawings showing slide gate installation dimensions and details and materials of construction of all slide gate components as called for in Master Specification, Section 1180, Submittals. Complete wiring and control diagrams shall be submitted in accordance with Master Specification, Division 16000, Electrical and Division 17000, Instrumentation and Controls.

1.4 DELIVERY STORAGE AND HANDLING. Slide gates are provided with locking plates to hold the disc firmly in place in the guides during shipping and installation. Gates can be lifted by a chain or sling through the stem hole in the disc only when locking plates are in place. When lifting gates, take special care to protect machined surfaces and wedges. Locking plates must be removed before opening gate.

Equipment should be stored in a clean, dry area on planks or timbers over an even surface to keep them off the ground and to prevent distortion. Equipment should also be covered to protect seat facings and other machined surfaces from foreign matter. Slide gates should not be stacked more than three high, and then, only with heavy timber blocking placed between the gates to prevent damage to gates.

To prevent bending when lifting, handling and storing, stems should be supported over their full length. The threaded portion of the stem is protected by a heavy fiber cover, which should not be removed until the stem is ready for installation. Couplings and thrust nuts are shipped in place on the stems and should be removed prior to installation. Stop collars are normally shipped in a bag or box accompanying the floor stands. Operating mechanisms should be handled and treated as precision machinery and protected accordingly.

1.5 WARRANTY. The manufacturer shall furnish to the Owner the warranty as specified in the Master Specification Section 01170, Warranties and Bonds, for the equipment and materials installed under this section of the specifications. Upon receipt of notice from the Owner of failure of any part of the guaranteed materials or equipment during the warranty period, new replacement part or parts shall be furnished and installed promptly by the Contractor at no additional cost to the Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Slide gates shall be as manufactured by Rodney Hunt Company, Hydro Gate Corporation, Watermain Industries or equal.

2.2 MATERIALS. Materials shall conform to the following specifications, however, the materials subject to dezincification or dealuminization shall not be used. The manufacturer/supplier shall make a declaration to this effect.

Thimble, frame, guides, slide, stem guides, and gear housing	Cast-iron – ASTM A126, class B; or ASTM A48, class 30.
Yoke and pedestal	Cast-iron – ASTM A126, Class B; or ASTM A48, class 30; or steel - ASTM A36.
Gears	Steel – AISI 8620, AISI 4140, or AISI 1117; bronze – ASTM B148 (CA 952, CA 954, or CA 958), ASTM B584 (CA 865 or CA 867).
Bearings	Bronze – ASTM B148 (CA 954).
Wedges	Bronze – ASTM B584 (CA 836, CA 865, CA 863, or CA 873).
Stem couplings	Bronze – ASTM B584 (CA 865, CA 863, or CA 873 stainless steel - ASTM A582, type 303; or ASTM A276, type 302 or 304.
Thrust nut and gate actuator lift nut	Bronze – ASTM B584 (AC 865, CA 863, or CA 873), ASTM B505 (C95800).
Seating faces and stem guide	Bronze – ASTM B21 (CA 464 or CA 482), ASTM B138 (CA 675), ASTM B98 (CA 651 or CA 655), ASTM B139 (CA 510); or ASTM B584 (CA 836, CA 865, CA 863 or CA 873); stainless steel - ASTM A276, type 302 or 304.
Stem guide bushings	Bronze – ASTM B584 (CA 932 or CA 873), ASTM B98 (CA 651 or CA 655), or ASTM B139 (CA 510).
Stems	Stainless steel ASTM A582, type 303; or ASTM A276, types 302 or 304.
Anchor bolts and fasteners	Stainless steel ASTM F593 or ASTM F594, alloy group 1 or group 2; or bronze - ASTM B98 (CA 651 or CA 655).
Flush-bottom seal	Elastomeric materials - ASTM D2000.
Flush-bottom retainer bar	Cast-iron – ASTM A126, class B; stainless steel - ASTM A276, type 302 or 304; ASTM A582, type 303; bronze - ASTM B98 (CA 651 or CA 655); or ASTM B138 (CA 675).

2.2.01 Slide Gate. Cast iron slide gate shall have frame and slide. The frame and slide shall have embedded bronze seating strips, which shall be pressed together by the attached wedging devices when the gate is closed.

Slide gates shall be cast-iron, bronze mounted heavy duty, flanged frame, with or without flush bottom closure as scheduled on the Drawings. Each gate shall be equipped with an adjustable side and top wedge system and designed for a maximum seating or unseating head of water as scheduled on the Drawings.

The gate slide shall be made of cast iron faces and be of one-piece construction, with strengthening ribs where required; and a reinforced section to receive the seating faces. The slide shall be square or rectangular in shape with integrally cast vertical and horizontal reinforcing ribs. A heavy reinforcing rib along each side shall be provided to ensure rigidity between side wedges. The slide shall be designed to operate under maximum specified differential head with the minimum safety factory of five (5). Guide tongues along each side of the slide shall be machined accurately on contact surfaces. A nut pocket shall be cast on the vertical centerline of the gate and shall be provided with a threaded block for attaching the stem to the slide. Pads for side wedges and top and bottom wedges, when required shall be integrally cast on the slide and machined to receive the adjustable wedges. The maximum allowable clearance between the slide and the slide guide shall be 1/16 in (1.6 mm).

2.2.02 Frame. The gate frame shall be cast iron and be of ample section and cast in one-piece. The frame shall be designed for the seating and unseating head indicated on the drawings with a minimum safety factor of five (5). All surfaces forming joints or bearings shall be machined. The frame shall be machined on the rear face to bolt directly to the machined face of the wall.

2.2.03 Frame Guides. The slide gate guides shall be made of cast iron and bolted to the frame or cast integrally with it. Guides shall be machined on all bearing and contact faces. Guides shall be designed for the design head indicated with a minimum safety factor of five (5). The guides shall be of such length so as to support at least one-half the vertical height of the slide when the slide is in the open position.

The extension of the gate guides shall be securely anchored to the concrete by means of Type 316 stainless steel anchor bolts, nuts, and pipe spacers. The anchor bolts shall be embedded in the concrete not less than 8 inches (20.3 cm), and the guide slots shall be machined and lined for the full length of the guides with bronze linings. In the case, where the guides are not integrally cast, they shall be doweled and bolted to the gate frame, and the brackets in contact with the wedges on the slide shall be heavily ribbed to withstand the thrust due to water pressure and wedging action of the slide wedges, and shall be machined and fitted with bronze wedge facings, which shall be machined on all bearing surfaces to make accurate contact with the wedges. Guide grooves shall be machined on all contact faces.

Overall clearances with slide tongue shall be not more than 1/8 in (3.2 mm). Faces for mounting of wedging devices shall be fully machined. Frames shall be self-contained (S/C) as listed in the “Gate Schedule.”

Round opening gates shall have a circular flange cast as part of the frame for mounting to a wall or pipe flange. All wall thimble-mounted gates shall have a square or rectangular flanged-back frame. The frame shall be fully machined and drilled to match the wall thimble. Gates mounted on pipe flanges shall be furnished with partial drilling per manufacturer’s recommendations.

2.2.04 Yoke. Self-contained gates shall be provided with a cast-iron or structural-steel yoke designed to withstand the thrust of the floorstand or hoist when a 40 lbf (178 N) effort is placed on the handwheel or crank with a safety factor of five (5). The top of the yoke shall be machined to receive the operating mechanism. The pads on the yoke that contact those on the top of the guides shall be machined on contact faces and bolted to the guides.

2.2.05 Wall Thimble. The wall thimble shall be made of cast iron and shall be provided by gate manufacturer. A pipe flange or F-shaped or E-shaped, shall be provided with a suitable end for attaching to the connecting opening as specified on the Gate Schedule. The front or mounting flange, shall be machined and shall be drilled and tapped to the same template used for its particular gate frame. A ring shall be cast on the periphery of the wall thimble to form a water stop and anchor ring in the concrete. Thimbles shall be of such dimensions and design as approved by the Engineer. The gate shall be attached to the wall thimble with bolts or studs to withstand the design forces with a safety factor of five (5). For gate mounting to thimbles, an adequate number of holes shall be provided in the flange on the back of the gate to prevent leakage under the design heads and to resist the shearing action caused by closing and opening forces.

2.2.06 Stem. The top of the stem shall project at least 1 inch (2.54cm) above the operating lift nut when gate is in closed position. Stems shall be manufactured from stainless steel sized to withstand the axial compressive and tensile forces created during gate operation under the specified differential heads and to transmit in compression at least two (2) times the rated output of the lift with a 40 lbf (178 N) effort on the crank or handwheel, or (1.25) times the stall thrust of the electric actuator. Threading on stems shall be rolled with double-lead threads of the Acme type. Cut threads will not be allowed. The contact surfaces of the threads shall have a maximum 16 micro-inch (406 micro-mm) finish. Stem couplings shall have internal threads for transmitting the full thrust of the stem and shall be held in place on the stem with a key, simultaneously engaging the coupling and both stems. The Stem couplings, if required, shall be made of bronze.

2.2.07 Stem Guides. Stem guides shall be fully adjustable, heavy duty castings, with 2 piece cast bronze removable collars. The stem guides shall be properly spaced to support the stem as a long column, with maximum spacing not to exceed a l/r (length/radius of gyration) of 200.

2.2.08 Wedges. The gate slides shall be equipped with adjustable bronze wedges of approved design to provide uniform distribution of the seating and unseating pressure. Each slide shall have machined pads for the wedges. The number, arrangement, location, and method of adjustment of the wedges shall ensure that any leakage occurring shall be 0.1 gallon per minute per linear foot (0.378 L/min per 30.5 cm) of the surface perimeter. The wedges shall be held in place and adjusted by means of bronze studs, nuts, and washers and shall be machined on all bearing surfaces and shall make accurate contact with the wedge seats attached to the frame.

2.2.09 Seals. Resilient seals for flush-bottom gates shall be extruded or molded natural or synthetic rubber. Reclaimed rubber shall not be used. Flush-bottom gates shall be provided with a frame-mounted flush-bottom seal. The solid bulb resilient rubber seal shall be firmly held in place using stainless steel retainers and corrosion-resistant fasteners. The full length of the bottom edge of the slide shall be machined for making uniform contact with the seal when it is mounted on the frame. The differential pressure on the rubber seal shall be variable by adjustment of wedges on the gate. The seal shall be designed to provide for the minimum leakage as specified.

2.2.10 Painting. All iron and steel surfaces except machined surfaces, submerged or non-submerged, shall be surface prepared and shop painted as defined in Master Specification Section 09900, Painting, Paragraph 2.2 Materials using National Sanitation Foundation Standard 61 certified products.

2.2.11 Manual Lifting Devices. The manual lift mechanism shall have either a direct drive handwheel without reduction gearing, or shall be crank-actuated with either single or double-reduction gearing, as necessary to meet lifting capacity required. The lift mechanism shall be sized to permit slide operation with an effort of not more than 40 lbf (178 N) pull on the handwheel/handcrank or 50 lbf-ft (68 N-m) torque on the lift nut or input shaft, depending on the lift type. Maximum pull or torque to start the slide in motion must not exceed one and one-half times this amount. All components of the lift mechanism shall be designed to withstand these input efforts or torque’s with a minimum safety factor of five (5). The floor stand shall have a weatherproof, housing, with a bronze-operating nut, mounted on a high strength pedestal. Tapered roller bearings shall be located above and below the flange on the lift bronze operating nut to support the output thrust of the floor stand.
The gearing shall be accurately cut and be of proper design to support the load conditions without undue stress. The shaft shall be mounted to provide low friction operation and to resist axial and radial thrusts.

Mechanical seals shall be provided around the operating nut and the pinion shaft to prevent lubrication from leaving the unit and moisture from entering the sealed housing. The reduction gear case shall be precision machined and equipped with roller or needle bearings sealed about the reduction shafts. Lubrication fittings shall be provided for all bearings. Crank operated floor stands will be selected so that no more than 40 lbf (178 N) effort shall be needed on the crank to open or close the slide gate. Crank handles and handwheels shall be worked with the direction of rotation to open the valve (usually counterclockwise). Each crank handle or handwheel shall have cast there on the word “Open” and an arrow indicating the direction to open. The number of turns required to close the gate shall be worked in an appropriate and visible location.

2.2.12 Electric Operators. Electric operators shall be as per AWWA standard C-540 and Master Specification, Section 15180, Valve and Gate Actuators.

PART 3 – EXECUTION

3.1 INSTALLATION.

3.1.01 Erection. Installation of the slide gates, guides, stem supports, and operators shall be in accordance with the manufacturer’s detailed instructions.
Prior to the pouring of concrete for the wall containing the slide gate, the wall thimble shall be accurately placed in the wall forms in accordance with the manufacturer’s instruction. Each wall thimble shall be internally braced and bolted to the forms to prevent any distortion during installation operations. Each operator shall be accurately set and plumbed and shall be in proper alignment with the gate and stem before it is installed in place. Operating stems shall be installed in proper alignment and shall not bind in the lift nut or stem guides.

3.2 FIELD QUALITY CONTROL. If inspection or tests disclose defects or non-compliance with the provisions of these specifications, such defects or improperly installed work shall be replaced or adjusted and the tests repeated until compliance with these specifications is obtained.

3.2.01 Field Testing. The slide gate shall be tested by being completely operated from open to closed positions in the presence of the Engineer with the head on the gate at maximum elevation as directed by the Engineer. Under these conditions, the gates shall move freely in their guides without binding, and the stems shall be truly vertical with no perceptible side play, and stand shall be tested for mechanical operation. All slide gates shall be tested for leakage. The wedges shall be adjusted to ensure that any leakage, which occurs, does not exceed the amount permitted by AWWA C-501. The Contractor shall make all arrangements; provide all necessary labor, materials, or equipment; and make all adjustments necessary for the performance of operating test which must be conducted in the presence of the Engineer.

3.2.02 Inspection. A representative of the manufacturer shall be present during installation and shall instruct the Contractor's personnel in proper installation procedures and supervise the installation. He shall approve the installation and witness the test.

3.3 MAINTENANCE. Complete training, operation and maintenance requirements shall be provided including complete manufacturers product data in accordance with Master Specification, Section 01160, Training and Operations & Maintenance Manuals. The manufacturer's representative shall instruct the Owner's personnel in the proper operation and maintenance of the Slide Gates.

End of Section

SECTION 15084

STOP LOGS

PART 1 – GENERAL

1.1 SCOPE. This section covers stop logs which shall be furnished complete with guides, seals, relevant hardware and appurtenances.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Contractor and subsequently approved by the Engineer. Stop logs shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest products of a manufacturer regularly engaged in the production of stop logs. Each stop log shall be provided with a number plate. Numerals shall be at least 1 inch high and shall be black backed enamel on anodized aluminum plate. The location of number plates and the method of attachment shall be acceptable to the Contractor. The number assigned to each stop log shall be as determined by the Contractor. Log shall be such that the flexural stresses do not exceed 1/5 of ultimate strength or 1/3 of yield strength. Design flexural stress of aluminum shall not exceed 7,000 psi (335 kPa). Log and lifting beam design shall be such that the flexural stresses do not exceed 1/5 of ultimate strength or 1/3 of yield strength. Design flexural stress of aluminum shall not exceed 7,000 psi (335 kPa).

1.3 SUBMITTALS. Complete drawings, construction details, and specifications covering the stop logs and appurtenances shall be submitted in accordance with the submittal section. Each drawing shall be identified with the stop log designation as relevant to the Work.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Provide stop logs and related furnishings as manufactured by Rodney Hunt Company, Fontaine, Waterman, Hydrogate, or approved equal.

2.2 MATERIALS.

Stop Logs	Aluminum B308 6061-T6 or Stainless Steel Type 316L

Lifting Lugs	Aluminum B308 6061-T6 or Stainless Steel Type 316L
Guides	Aluminum B308 6061-T6 or Stainless Steel Type 316L
Seals	
1. Sides	Lip Seal–ASTM D2000, Grade 2BC 615, Extruded Neoprene, Durometer 50
2. Bottom	Flush Lip Seal-ASTM D2000, Grade 2BC 515, Extruded Neoprene, Durometer 50

2.3 FABRICATION. Stop logs shall be of one piece extruded aluminum, or fabricated stainless steel. Stop log panels shall be of height indicated and in height increments set by the manufacturer. Panels made of two or more extrusions shall be securely welded together to form a unit and joints shall be made watertight with neoprene seals or seal welding. All welding shall be in accordance with latest applicable codes of the American Welding Society (D1.2 for aluminum and D1.3 for stainless steel). The stop logs shall be fabricated in separate panels such that the largest panel is no greater than 8 feet (2.4 m) in height. Each panel shall have two stainless steel hooks to engage the lifting device. Adequate drainage and rapid release of air shall be provided for each log. The bottom of the log shall be extruded in a way to accept a specially extruded resilient seal to provide a flush bottom closure. The shape of the lip seal shall provide a seating surface having a minimum width of 1 inch (2.4 cm). The vertical face of the seal shall be in contact with the seating surface of the guide or seal located on the frame to provide a proper seal at the corners. Stop logs shall be of sufficient weight to be submerged under their own weight.

2.4 GUIDES. The guides shall be of extruded aluminum or stainless steel, whichever material is the same as chosen for the logs, and shall be structural shapes or formed plates. The guides shall be designed for maximum rigidity and will be provided with a strap on the back of the guides for the embedded type to lock it into the concrete, or with a side angle for surfacing mounting using anchor bolts. The invert of the frame shall be an angle or channel welded to the lower ends of the guides to form a seating surface for the resilient seal mounted on the stop log.

2.5 SEALS. The seals shall be located along the bottom of the log section, between each stop log panel and along both sides of the log. Seals shall be mechanically attached to the log. Adhesives alone are not an acceptable mounting method. Seals shall be mounted in a manner that allows for easy replacement in the event of damage. Lip type seals shall be attached to the frame to restrict leakage. Under the condition which the log will be subjected to flow in both directions, the log and guide shall be provided with seals in both directions.

2.6 HARDWARE. All necessary attaching bolts and anchor bolts shall be stainless steel and furnished by the stop log manufacturer.

2.7 LIFTING DEVICE. Lifting device shall be suitable for inserting, retrieving and handling stop log panels. One (1) lifting device shall be provided for each stop log width. The lifting device shall be equipped with a suitable eyebolt for crane operation. The device shall be guided by the slot of the guide extrusion, and shall be capable of securing and releasing the stop logs panels with the use of a lanyard from the operating floor. The device shall be furnished with non-metallic wheels to guide the device in the slot. The lifting device may, at the manufacturer's option, be adjustable in widths to accommodate several widths of stop log openings.

2.8 PAINTING. All aluminum in contact with concrete shall have a heavy shop coat of bitumastic paint.

PART 3 – EXECUTION

3.1 INSTALLATION. The installation of all parts shall be done in a workmanlike manner and in accordance with detailed technical installation procedures supplied by the manufacturer.

3.2 TESTING. Upon completion of the installation, the contractor shall be required to make performance tests of the stop logs in the field, under the direction of the Engineer. Tests shall be performed in accordance with the requirements of Master Specification Section 01180, Equipment, Material, Parts and Tools.

3.3 FIELD QUALITY CONTROL. It shall be the Contractor's responsibility to handle, store, and install the stop logs in. strict accordance with manufacturer's drawings and recommendations. All stop logs of the same dimension shall be interchangeable from one slot to another and shall be tested for such interchangeability by actually installing each stop log in each slot in the field. Any maladjustment shall be corrected to the satisfaction of the Engineer.

End of Section

SECTION 15090

ANGLE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated angle valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Nameplates shall have black baked enamel letters at least 3/4 inch (19 mm) high on anodized aluminum plate.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Angle valves shall be suitable for use as throttling valves.

2.1.01 Valves VA-1.

Rating	Class 125
Code	MSS SP-80, Type 1
Body/Bonnet	ASTM B62, bronze, threaded bonnet, threaded packing nut, rising stem
Trim	
Seat	Integral to body
Disc	ASTM B62, bronze
Stem	ASTM B62, bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	-20 to 150°F (-29 to 66°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "504", or approved equal

2.1.02 Valves VA-2.

Rating	Class 150
Code	MSS SP-80, Type 2
Body/Bonnet	ASTM B62, bronze, union bonnet, threaded packing nut, rising stem
Trim	
Seat	Integral to body

Disc	PTFE
Stem	ASTM B62, bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	-20 to 150°F (-29 to 66°C)
Valve Operator	Handwheel
Manufacturers	Stockham "B-222T", Walworth "Fig 3096", or approved equal

2.1.03 Valves VA-3.

Rating	Class 125
Code	MSS SP-85, Type II
Body/Bonnet	ASTM A126, Class B, cast iron, bolted bonnet, OS&Y, rising stem
Trim	
Seat	ASTM B62, bronze, renewable
Disc	ASTM B62, bronze, renewable
Stem	ASTM B16, brass
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Flanged, flat faced
Temperature Limitations	-20 to 150°F (-29 to 66°C)
Valve Operator	Handwheel
Manufacturers	Powell "Fig 1254", or approved equal

2.1.04 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.05 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.06 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.
All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1. INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15091

MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of 4 inch and smaller, manually operated or remote activated, two position (open-close) ball valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

Ball valves larger than 4 inch are covered in Master Specification Section 15103, AWWA Ball Valves.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VB-1.

Rating	500 psi (3.4 MPa]) nonshock cold WOG
Code	MSS SP-110
Type	In-line, two piece, end entry, regular port
Body/Bonnet	ASTM B584–C84400 bronze or ASTM B194, Grade 377, brass
Trim	
Seat	Reinforced Teflon
Ball	Brass, or chrome plated brass
Stem	Brass
Thrust Washer	Reinforced Teflon
Stem Seal	Teflon or Viton
End Connection	Threaded
Temp. Limitations	-20 to 400°F (-29 to 204°C])
Manufacturers	Conbraco Industries "Apollo 70-100 Series"; Powell "Fig 4210T", or approved equal

2.1.02 Valves VB-2.

Rating	800 psi (5.5 MPa) nonshock cold WOG

Code	MSS SP-110
Type	In-line, two piece, end entry, regular port
Body/Bonnet	ASTM A3512-CF8M stainless steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A276-316, stainless steel
Stem	ASTM A276-316, stainless steel
Thrust Washer	Reinforced Teflon
Stem Seal	Teflon or Viton
End Connection	Threaded
Temp. Limitations	-20 to 400°F (-29 to 204°C])
Manufacturers	Conbraco Industries "Apollo 76-100 Series"; Neles-Jamesbury "Series 300", or approved equal

2.1.03 Valves VB-3.

Rating	1000 psi (6.5 MPa) nonshock cold WOG
Code	MSS SP-110, NACE MR-01-75
Type	In-line, three piece, bolted body, regular port
Body/Bonnet	ASTM A351-CF8M, stainless steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A276-316, stainless steel
Stem	ASTM A276-316, stainless steel

Thrust Washer	Reinforced Teflon
Stem Seal	Reinforced Teflon
End Connection	Socketwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Conbraco Industries "Apollo 85-200 Series"; Neles-Jamesbury "Series 4000", or approved equal

2.1.04 Valves VB-4.

Rating	Class 150
Code	MSS SP-72
Type	In-line, split body, full port
Body/Bonnet	ASTM A216-WCB, cast steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A216-WCB, steel, chrome plated
Stem	ASTM A108-CS
Thrust Washer	Reinforced Teflon
Stem Packing	Manufacturer’s standard
End Connection	Flanged, ASME B16.5, Class 150, raised face
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Conbraco Industries "Apollo 88-200 Series", or approved equal

2.1.05 Valves VB-5.

Rating	Class 150
Code	MSS SP-72
Type	In-line, end entry, regular port
Body/Bonnet	ASTM A216-WCB, cast steel
Trim	
Seat	Reinforced Teflon
Ball	ASTM A216-WCB, steel, chrome plated
Stem	ASTM A108-CS
Thrust Washer	Reinforced Teflon
Stem Seal	Manufacturer’s standard
Body Seal	Reinforced Teflon
End Connection	Flanged, ASME B16.5, Class 150, raised face
Temp. Limitations	-20 to 400°F [-29 to 204°C]
Manufacturers	Conbraco Industries "Apollo 88-100 Series"; Neles-Jamesbury "Series 5000"; Powell "Fig 4224T", or approved equal

2.1.06 Valves VB-6.

Rating	800 psi [5.5 MPa] nonshock cold WOG
Code	ASME B16.34
Type	In-line, three piece, bolted body, full port
Body/Bonnet	ASTM A216-WCB, cast steel or ASTM A105, forged steel

Trim	
Seat	Reinforced Teflon
Ball	ASTM A108-CS, chrome plated
Stem	ASTM A108-CS
Thrust Washer	Reinforced Teflon
Stem Seal	Reinforced Teflon
End Connection	Socketwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Conbraco Industries "Apollo 83-200 Series", Contromatics "C-1122-BB-DL", Neles-Jamesbury "4000 Series", or approved equal

2.1.07 Valves VB-7.

Rating	800 psi 95.5 MPa) nonshock cold WOG
Code	ASME B16.34
Type	In-line, three piece, bolted body, regular port
Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
Trim	
Seat	Reinforced Teflon
Ball	Nickel or hard chrome plated carbon steel
Stem	Nickel or hard chrome plated carbon steel
Thrust Washer	Reinforced Teflon

Stem Seal	Reinforced Teflon
End Connection	Buttwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Contromatics "C-1133-BB-DL", or approved equal

2.1.08 Valves VB-8.

Rating	Class 600
Code	ASME B16.34
Type	In-line, three piece, bolted body, firesafe, regular port
Body/Bonnet	ASTM A105, forged steel
Trim	
Seat	Reinforced Teflon primary, metal secondary
Ball	Stainless steel
Stem	Hard chrome plated carbon steel
Thrust Washer	Reinforced Teflon
Stem Seal	Reinforced Teflon
End Connection	Socketwelded
Temp. Limitations	-20 to 400°F (-29 to 204°C)
Manufacturers	Contromatics "C-1122-BB-FS"; Neles-Jamesbury "4C2236TT-1", or approved equal

2.1.09 Valves VB-9.

Rating	150 psig [1.0 MPa] nonshock cold WOG

Code	MSS SP-122
Type	In-line, true union, full port (Schedule 80)
Body/Bonnet	PVC or CPVC
Trim	
Seat	Teflon
Ball	PVC or CPVC
Stem	PVC or CPVC
Thrust Washer	Teflon
Stem Seal	Viton O-ring
End Connection	Socket
Temp. Limitations	0 to 140°F (-18 to 60°C])
Manufacturers	Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Hayward Plastic Products "True Union Ball Valve", or approved equal

2.1.10 Valves VB-10.

Rating	150 psig [1.0 MPa] nonshock cold WOG
Code	MSS SP-122
Type	In-line, true union, full port (Schedule 80)
Body/Bonnet	PVC or CPVC
Trim	
Seat	Teflon
Ball	PVC or CPVC

Stem	PVC or CPVC
Thrust Washer	Teflon
Stem Seal	Viton O-ring
End Connection	Flanged
Temp. Limitations	0 to 140°F (-18 to 60°C)
Manufacturers	Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Hayward Plastic Products "True Union Ball Valve", or approved equal

2.1.11 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.12 Rotation. The direction of rotation of the lever or handwheel to open the valve shall be to the left (counterclockwise).

2.1.13 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the Miscellaneous Ball Valve Schedule 15091-S01.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as indicated in the Miscellaneous Ball Valve Schedule 15091-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15092

INDUSTRIAL BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated two position (open-close) industrial type butterfly valves for low-pressure air service, chemical and odor control service, hot water heating system service, and other applications where AWWA type butterfly valves are not indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Valve discs shall seat at 90 degrees with the pipe axis.

Flanged end valves shall be of the short-body type. Where mechanical joint ends are indicated in the Contract Documents, either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11 will be acceptable. For buried or submerged service, shaft seals shall be O-ring type.

2.1.01 Valves VBF-1.

Rating	Class 150
Code	MSS SP-67
Body	ASTM A395, GR 60/40/18, ductile iron
Trim	
Seat	EPDM
Disc	ASTM B148, Alloy 952, aluminum bronze
Stem	ASTM A276, Grade 316 or 304, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Upper and lower bearings or two upper bearings, bronze or reinforced teflon
Shaft Seal	Synthetic rubber O-rings
End Connection	Wafer
Temperature Limitations	-20° to 250°F (-29° to 121°C)
Manufacturers	Keystone “AR1”, or approved equal

2.1.02 Valves VBF-2.

Rating	Class 150
Code	MSS SP-67
Body	ASTM A395, GR 60/40/18, ductile iron
Trim	
Seat	EPDM
Disc	ASTM B148, Alloy 952, aluminum bronze
Stem	ASTM A276, Grade 316 or 304, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Upper and lower bearings or two upper bearings, bronze or reinforced teflon
Shaft Seal	Synthetic rubber O-rings
End Connection	Lug flanged, ASME B16.5, Class 150 diameter and drilling
Temperature Limitations	-20° to 250°F (-29° to 121°C)
Manufacturers	Keystone “AR2”, or approved equal

2.1.03 Valves VBF-3.

Rating	Class 150
Body	PVC
Trim	
Seat	FPM (Viton) or EPDM
Disc	PVC or polypropylene

Stem	AISI Type 316 stainless steel
Stem Seal	Synthetic O-rings
Shaft Bearings	Upper and lower bearings, reinforced teflon
End Connection	Flanged, ASME B16.5, Class 150 diameter and drilling
Temperature Limitations	40° to 140°F (4° to 60°C)
Manufacturers	Chemtrol “Model B”, or approved equal

2.1.04 Valves VBF-4.

Rating	Class 150
Code	MSS SP-67
Body	ASTM A395 or A536, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM A296, CF8M, stainless steel
Stem	ASTM A296, CF8M, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Acetal
End Connection	Wafer
Temperature Limitations	0° to 212°F (-18° to 100°C)
Manufacturers	ABZ “Figure 090”, or approved equal

2.1.05 Valves VBF-5.

Rating	Class 150

Code	MSS SP-67
Body	ASTM A395 or A536, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM A296, CF8M, stainless steel
Stem	ASTM A296, CF8M, stainless steel
Stem Packing	Buna-N
Shaft Bearings	Acetal
End Connection	Lug flanged, ASME B16.5, Class 150 diameter and drilling
Temperature Limitations	0° to 212°F (-18° to 100°C)
-Manufacturers	ABZ “Figure 090”, or approved equal

2.1.06 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.07 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.08 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.

Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the Industrial Butterfly Valve Schedule 15092-S01.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Torque Tubes. Requirements for torque tubes shall be as indicated in the Industrial Butterfly Valve Schedule 15092-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.06 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15093

CHECK VALVES

PART 1 - GENERAL

1.1. SCOPE. This section covers the furnishing of check valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VC-1.

Rating	Class 150
Code	API-594
Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze
Springs/Hinge Pins/Stops	Stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 150, flat faced flanges
Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A125HZNSF", Stockham "WG-970", Mission "Duo-Chek II Figure 12HMP", Valve and Primer "9000AR1F", or approved equal

2.1.02 Valves VC-2.

Rating	Class 150
Code	API-594

Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze
Springs/Hinge Pins/Stops	Stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 150, flat faced flanges
Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A125HZNSF", Stockham "WG-970", Mission "Duo-Chek II Figure 12HMP", Valve and Primer "9000AR1F", or approved equal

2.1.03 Valves VC-3.

Rating	Class 300
Code	API-594
Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze

Springs/Hinge Pins/Stops	AISI Type 316 stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 300, raised faced flanges
Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A250HZNSR", Stockham "WG-970", Mission "Duo-Chek II Figure 25HMF", Valve and Primer "9200AR1R", or approved equal

2.1.04 Valves VC-4.

Rating	140 psig
Code	API-594
Type	Dual disc wafer
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Seat	Buna-N
Disc	ASTM B148 Alloy 952, aluminum bronze or ductile iron with bronze trim
Springs, Hinge Pins & Stops	AISI Type 316 stainless steel
Bearings	Teflon
End Connection	Plain, installed between ASME B16.5, Class 300, raised faced flanges

Temp. Limitations	-20° to 225°F (-29° to 107°C)
Valve Operator	None
Manufacturers	Marlin "Wafer Check A250HZNSR", Mission "Duo-Chek II Figure 25HMF", Valve and Primer "9200AR1R", or approved equal

2.1.05 Valves VC-5.

Rating	Class 125
Code	MSS SP-71, Type III, AWWA C508
Type	Horizontal swing, bolted bonnet
Body/Bonnet	ASTM A126 Class B cast iron
Trim	
Seat Ring	ASTM B763 Alloy 8440 bronze
Disc	ASTM A126, Class B, cast iron
Hinge Pins	Stainless steel
Bearings	Bronze bushings
Cover Gasket	Manufacturer’s standard
End Connection	Flanged, ASME B16.1, Class 125, flat faced
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	External spring
Manufacturers	American Flow Control "52 SC", M&H "Style 259-02", Mueller "A2600-6-02", or approved equal.

2.1.06 Valves VC-6.

Rating	Class 125

Code	MSS SP-71, Type I
Type	Horizontal swing, bolted bonnet
Body/Bonnet	ASTM A126, Class B, cast iron
Trim	
Seat Ring	Bronze
Disc	Bronze
Hinge Pins	Bronze or brass
Bushings	Bronze
Cover Gasket	Manufacturer’s standard
End Connection	Flanged, ASME B16.1 Class 125, flat faced
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	None
Manufacturers	Milwaukee "F-2974", Stockham "G-931", or approved equal

2.1.07 <u>Valves VC-7</u>.

Rating	Class 125
Code	MSS SP-80, Type III
Type	Horizontal swing, threaded bonnet
Body/Bonnet	ASTM B62 bronze
Trim	
Seat	Bronze, regrinding
Disc	Bronze
Hinge Pins	Manufacturer’s standard

End Connection	Threaded
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	None
Manufacturers	Stockham "B-321", Walworth "Fig 3406", or approved equal

2.1.08 Valves VC-8.

Rating	Class 125
Code	MSS SP-80, Type III
Type	Horizontal swing, threaded bonnet
Body/Bonnet	ASTM B62 bronze
Trim	
Seat	Bronze, regrinding
Disc	Bronze
Hinge Pins	Manufacturer’s standard
End Connection	Soldered
Temp. Limitations	-20° to 212°F (-29° to 100°C)
Valve Operator	None
Manufacturers	Nibco "S-413-B", Walworth "Fig 3046SJ", or approved equal

2.1.09 Valves VC-9.

Rating	Class 125
Code	API-594
Type	Dual disc wafer
Body	ASTM A126, Class B, cast iron

Trim	
Seat	EPDM
Disc	Aluminum
Hinge Pins	Aluminum
Springs	Stainless steel
Bushings	Manufacturer’s standard
End Connection	Plain, installed between ASME B16.1, Class 125, flat faced flanges
Temp. Limitations	-20° to 300°F (-29° to 149°C)
Valve Operator	None
Manufacturers	Techno Corporation "Technocheck Silent Seatless Check Valves", Hoffman "Air Check Valves", Lamson "Check Valves", or approved equal

2.1.10 Valves VC-10.

Rating	3000
Type	Poppet
Body	Stainless steel
Trim	
Poppet	Stainless steel
O-ring	Viton
Spring	Stainless steel
End Connection	Threaded
Temp. Limitations	-10 to 375°F [-23 to 191°C]
Valve Operator	None

Manufacturers	Circle Seal "224B" or Nupro "Series C", or approved equal.

2.1.11 Valves VC-11.

Rating	150 psig [1 MPa] nonshock
Type	Ball check, true union
Body	PVC or CPVC
Trim	
Ball	PVC or CPVC
Seat	Viton or EPDM
Seals	Viton or EPDM
End Connection	Socket
Temp. Limitations	0° to 140°F (-18 to 60°C)
Valve Operator	None
Manufacturers	Hayward Plastics Products "Ball Check Valve", Nibco "Chemtrol True Union Ball Check Valve", or approved equal.

2.1.12 Valves VC-12.

Rating	150 psig (1 MPa) nonshock
Type	Ball check, true union
Body/Bonnet	PVC or CPVC
Trim	
Ball	PVC or CPVC
Seat	Viton or EPDM
Seals	Viton or EPDM

End Connection	Flanged, ASME B16.5, Class 150, raised face
Temp. Limitations	0° to 140°F (-18° to 60°C)
Valve Operator	None
Manufacturers	Hayward Plastics Products "Ball Check Valve", Nibco "Chemtrol True Union Ball Check Valve", or approved equal.

2.1.13 Valves VC-13.

Rating	100 psig (690 kPa) nonshock
Type	Diaphragm, two piece
Body	PVC
Trim	
Diaphragm	Buna-N
End Connection	Threaded
Temp. Limitations	0° to 140°F (-18° to 60°C)
Valve Operator	None
Manufacturers	Plast-O-Matic "Series CK Check Valves" or "Series VB Vacuum Breakers", or approved equal

2.1.14 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.15 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15094

BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of backflow preventers and associated appurtenances.

Piping, pipe supports, insulation, and accessories that are not an integral part of the backflow preventers or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each backflow preventer covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the device in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications for each unit shall include, but shall not be limited to the following:

Name of manufacturer.

Type and model.

Net weight.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

Manufacturer shall submit certification that each backflow preventer and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of backflow preventer.

Contractor shall submit results of all pressure and leakage testing.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. Backflow preventers shall be designed to meet the requirements as indicated herein and on the backflow preventer scheduleand as indicated in the Contract Documents.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Design and Construction paragraph.

2.3 DESIGN AND CONSTRUCTION. Backflow prevention device type shall be as indicated in the backflow preventer schedule and as indicated in the Contract Documents.

2.3.01 Reduced Pressure Zone Backflow Preventers. Reduced pressure zone (RPZ) backflow preventers shall consist of isolation valves, two independent check valves, and differential relief valve. The assembly shall automatically reduce the pressure in the zone between the check valves. In the event that the reduced pressure is not maintained, the differential relief valve shall open, maintaining the proper zone differential. RPZ backflow preventers shall comply with AWWA C511-92 and ASSE Standard 1013 requirements and shall be suitable for horizontal installation. Each RPZ backflow preventer shall be provided with a relief valve air-gap drain fitting.

RPZ backflow preventers in 2 inch (50 mm) and smaller sizes shall be provided with bronze bodies and with a threaded bronze bodied ball valve on each end of the device. Two inch (50 mm) and smaller RPZ backflow preventers shall be Febco “Model 860”, Cla-Val Company “Model RP6L”, Watts Regulator “Series 909”, or approved equal.

RPZ backflow preventers in 2-1/2 inch (63 mm) and larger sizes shall be provided with ductile iron bodies, epoxy-coated interior and exterior, and a flanged, resilient-seated gate valve on each end of the device. Flange diameter and drilling shall conform to ANSI/ASME B16.1, Class 125. 2-1/2 inch (63 mm) and larger RPZ backflow preventers shall be Febco "Model 860", Cla-Val Company "Model RP7L", Watts Regulator Company "Series 909", or approved equal.

2.3.02 Hose Connection Vacuum Breakers. Hose connection vacuum breakers shall be provided with 3/4 inch (19 mm) hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be Watts Regulator Company "Series 8", or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15095

SOLENOID VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of solenoid operated valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Solenoid valves shall have packless construction without packing box or sliding seal.

Solenoid coils for ac service shall have voltage and frequency as indicated in the Contract Documents, encapsulated, Class F, for continuous duty at rated voltage plus or minus 10 percent and 40°C ambient, in a NEMA Type 1 or 4 enclosure, as required, with a conduit knockout.

Solenoid coils for dc service shall have dc voltage as indicated in the Contract Documents, Class H, for continuous duty at rated voltage plus or minus 10 percent and 40°C ambient, in a NEMA Type 1 or 4 enclosure as required, with a conduit knockout.

2.1.01 Valves VSOL-1.

Type	2-way, pilot operated
Body/Bonnet	Brass or bronze
Trim	
Seals	Buna-N or teflon
Disc	Buna-N or teflon
Stem	Manufacturer’s standard
Bonnet Gasket	Manufacturer’s standard
Spring	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	32° to 104°F (0 to 40°C)
Valve Operator	Integral
Manufacturers	ASCO "8210 Series", or approved equal

2.1.02 Valves VSOL-2.

Type	3-way, pilot operated
Body/Bonnet	Brass or bronze
Trim	
Seals	Buna-N or teflon
Disc	Buna-N or teflon
Stem	Manufacturer's standard
Bonnet Gasket	Manufacturer's standard
Spring	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	32° to 104°F (0° to 40°C)
Valve Operator	Integral
Manufacturers	ASCO "8316 Series", or approved equal

2.1.03 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.04 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid	Ameron "Amerlock 400 High-Solids

service)	Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 ACCESSORIES.

2.2.01 Manual Operators. Requirements for manual operators, to allow valve operation when electrical power is off, shall be as indicated in the Solenoid Valve Schedule 15095-S01.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15096

GLOBE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated, two position (open-close) globe valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VGL-1.

Rating	Class 200
Code	MSS SP-80
Type	In-line, union or threaded bonnet, rising stem, needle
Body/Bonnet	Bronze or brass
Trim	
Seat	Manufacturer’s standard
Stem	Bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	0° to 400°F (-18° to 204°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "600", Powell "Fig 180", Stockham "B-64", or approved equal.

2.1.02 Valves VGL-2.

Rating	Class 125
Code	MSS SP-80, Type 1

Type	In-line, metal disc, threaded bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Bronze
Stem	Bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	0° to 350°F (-18° to 177°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "502", Stockham "B-16", Walworth "Fig 3058", or approved equal

2.1.03 Valves VGL-3.

Rating	Class 125
Code	MSS SP-80, Type 1
Type	In-line, metal disc, threaded bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Bronze

Stem	Bronze
Bonnet Gasket	Manufacturer's standard
Stem Packing	Manufacturer's standard
End Connection	Soldered
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "1502", Stockham "B-17", or approved equal

2.1.04 Valves VGL-4.

Rating	Class 150
Code	MSS SP-80, Type 2
Type	In-line, composition disc, union bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Teflon
Stem	Bronze
Bonnet Gasket	Manufacturer's standard
Stem Packing	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	0° to 350°F (-18° to 177°C)
Valve Operator	Handwheel

Manufacturers	Milwaukee "590", Stockham "B-22T", Walworth "Fig 3095", or approved equal

2.1.05 Valves VGL-5.

Rating	Class 150
Code	MSS SP-80, Type 2
Type	In-line, composition disc, union bonnet, rising stem
Body/Bonnet	ASTM B62, bronze
Trim	
Seat	Integral to body
Disc	Teflon
Stem	ASTM B62, bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Teflon impregnated
End Connection	Soldered
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "1590", or approved equal

2.1.06 Valves VGL-6.

Rating	Class 150
Code	MSS SP-85, Type I
Type	In-line, bolted bonnet, OS&Y rising stem

Body/Bonnet	ASTM A126 Class B, cast iron
Trim	
Seat Ring	ASTM B62, bronze
Disc	ASTM B62, bronze
Stem	Brass or silicone bronze
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Flanged, ASME B16.1, Class 125, flat faced
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Handwheel
Manufacturers	Milwaukee "F2981", Powell "Fig 1253", Walworth "8096F", or approved equal

2.1.07 Valves VGL-7.

Rating	Class 250
Code	MSS SP-85 Type 1
Type	In-line, single seated, top guided, bolted bonnet
Body/Bonnet	Cast iron
Trim	
Plug	316 stainless steel
Seat Ring	316 stainless steel
Stem	Manufacturer’s standard

Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Threaded
Temp. Limitations	0° to 250°F (-18° to 121°C)
Valve Operator	Electric
Manufacturers	Dezurik “Series 1400”, or approved equal

2.1.08 Valves VGL-8.

Rating	Class 125
Code	MSS SP-85, Type 1
Type	In-line, single seated, cage, bolted bonnet
Body/Bonnet	Cast iron
Trim	
Plug	17-4 PH stainless steel
Seat Ring	17-4 PH stainless steel
Stem	Manufacturer’s standard
Bonnet Gasket	Manufacturer’s standard
Stem Packing	Manufacturer’s standard
End Connection	Flanged, ASME B16.1, Class 125, flat faced
Temp. Limitations	0° to 350°F (-18° to 177°C)
Valve Operator	Electric
Manufacturers	Dezurik “Series 9100”, or approved

equal

2.1.09 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.10 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.11 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Coating Materials	
Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged,	Asphalt varnish.

or Installed in Manholes or Valve Vaults	
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coatedwith the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15097

PINCH VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated, two position (open-close) pinch valves for the services indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves. Pinch valves shall be of full body construction, with flexible sleeve liner, and 100 percent port area of the joining pipe at the valve ends. The valve area shall be 100 percent of the full pipe area through the entire length of the valve. All metal parts are to be completely protected from the process fluid by a flexible elastomer liner. Each valve shall be throttled and fully closed with compressed air that constricts the sleeve at the center of the valve. Each valve body shall be drilled and tapped for a pressure connection on top and bottom of the housing.

The elastomer liners shall be manufactured from elastomer with polyester reinforcement ply and with flanges. Metal reinforcements in valves sized 6 inches (150 mm) and larger shall be molded into the liner flanges. The elastomer liner shall be pre-pinched and shall be field replaceable. Two piece liners shall be identical and shall lock into position without separate gaskets or adhesives. The metal body shall consist of two identical halves.

The calculated bursting pressure of the elastomer liner shall be four times the rated working pressure of the valve. The valve shall be able to handle surge pressures of 150 percent of the working line pressure without breakage.

Rating	Class 150
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Liner	Buna-N
End Connection	Flanged, ASME B16.5, Class 150, flat faced
Temp. Limitations	40 to 225°F (4 to 107°C)
Valve Operator	Integral, pneumatic
Manufacturers	Fowler “Delta Series”, or approved equal

2.1.02 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.03 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15098

PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manually operated or remote activated, two position (open-close) plug valves for the services as indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Valves VP-1.

Rating	175 WOG
Code	
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Plug Seal	Hycar
Plug	Bronze or nickel plated cast iron
Stem Seal	Buna
End Connection	Threaded
Temp. Limitations	-20 to 180°F (-29 to 82°C)
Valve Operator	Lever
Manufacturers	Key Port "Fig 425-RS51", or approved equal

2.1.02 Valves VP-2.

Rating	175 WOG
Code	
Body	ASTM A536, GR 65/45/12, ductile iron
Trim	
Plug Seal	Hycar
Plug	Bronze or nickel plated cast iron

Stem Seal	Buna
End Connection	Flanged, ASME B16.1, Class 125
Temp. Limitations	-20 to 180°F (-29 to 82°C)
Valve Operator	Lever
Manufacturers	Key Port “Fig 425-RS51”, or approved equal

2.1.03 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.04 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.05 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.3 ACCESSORIES.

2.3.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.02 Position Indicators. Requirements for position indicators shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.03 Floor Boxes. Requirements for floor boxes shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.04 Operating Stands. Requirements for operating stands shall be as indicated in Master Specification Section 15180, Valve and Gate Actuators.

2.3.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coatedwith the manufacturer’s standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15099

PRESSURE REDUCING VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of pressure reducing valves for gas, air, and water service as indicated in the Contract Documents.

Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.

Type and model.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. Pressure reducing valves shall be designed to meet the requirements as indicated herein and on the Pressure Reducing Value Schedule 15099-S01 and as indicated in the Contract Documents.

Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2.3 MATERIALS. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel (NSF certified)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", approved equal; immersion service.
Epoxy Enamel (Natural Gas Service)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series N69 Hi-Build Epoxoline II", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.

2.4 CONSTRUCTION.

2.4.01 Water Service. Pressure reducing valves for water service shall be direct-acting or pilot-operated type as indicated in the Pressure Reducing Valve Schedule.

Direct-acting valves shall be globe type with threaded connections and union assembly. The valves shall be provided with bronze body and cover, stainless steel trim, reinforced neoprene diaphragm, Buna-N disc, and stainless steel strainer. Direct-acting pressure reducing valves shall be Cla-Val “Model 990”, Cash-Acme, Watts, or approved equal.

Pilot-operated valves shall be globe type with flanged ends. The valves shall be provided with epoxy coated ductile iron body, bronze trim, and Buna-N rubber diaphragm and disc. The pilot regulating valve shall be bronze with stainless steel trim. Pilot-operated pressure reducing valves shall be Cla-Val “Model 990”, Cash-Acme, Watts, or approved equal.

When indicated in the schedules, pilot-operated valves shall be equipped with a low flow bypass. The low flow bypass shall consist of a direct-acting pressure reducing valve in parallel with the pilot-operated valve. The valves and required piping assembly shall be factory assembled and shall be Cla-Val “Model 90-48”, or approved equal.

2.4.02 Gas Service. Pressure reducing valves for natural gas and propane gas service shall be suitable for gases with specific gravities of 0.6 and 1.5, respectively. Natural gas and propane gas pressure reducing valves shall be direct-acting type with cast iron or cast steel bodies, threaded ends, aluminum trim, and a nitrile diaphragm and disc. Valves shall be Fisher Controls "S-102/S-201 Series", or approved equal.

Pressure reducing valves for digester gas service shall be suitable for gas with specific gravity of 0.8 to 0.9. Digester gas pressure reducing valves shall be pilot-operated type with stainless steel bodies, stainless steel trim, viton diaphragm, and stainless steel pilot. Valves shall be Fisher Controls "1098-EGR Series", or approved equal.

2.4.03 Air Service. Pressure reducing valves for air service shall have a cast iron or steel body with stainless steel trim and a composition disc. Pressure reducing valves shall be furnished with integral or line mounted inlet filters/strainers and discharge pressure gauges. Valves shall be as manufactured by Fisher Controls; Jordan Valve Div., Richards Industries; O. C. Keckley Co.; Leslie Controls, Inc.; Spirax Sarco, Inc; or approved equal.

2.5 SHOP COATING. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting .

<u>Surfaces to be Coated</u>

Interior Surfaces	
Liquid Service	Epoxy (NSF certified).
Fuel Gas and digester Gas Service	Epoxy.
Exterior Surfaces	Universal primer.

PART 3 - EXECUTION

3.1 <u>INSTALLATION</u>. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

End of Section

SECTION 15100

MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of miscellaneous valves as indicated in the Contract Documents. This section includes the following types of valves:

Hose faucets
Wall hydrants
Wall hydrants with vacuum breaker
Yard hydrants
Post type yard hydrants
Curb stops

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment , Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.02 Number Plates. Each valve covered by this section, that has been assigned a number on the drawings, shall be provided with a number plate mounted on or adjacent to the valve in a manner acceptable to Engineer. Number plates shall be aluminum with engraved letters at least 3/4 inch (19 mm) high. Letters shall be painted black after fabrication.

1.3 SUBMITTALS. Complete drawings, details, and specifications, covering the valves and their appurtenances shall be submitted in accordance Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180,Equipment , Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

2.1.01 Length Tolerance. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch (1.6 mm) of the specified or theoretical length.

2.1.02 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.1.03 Shop Coatings. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for NSF 61 liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces

Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Asphalt varnish.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 HOSE VALVES AND HYDRANTS.

2.2.01 Hose Faucets, VHF-1.

Type	Faucet, threaded bonnet
Body/Bonnet	Brass
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, male NPT x male HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	T-handle
Manufacturers	Chicago Faucets "No. 7T", Tanner "1235", or approved equal

2.2.02 Wall Hydrants, VHF-2.

Type	Freeze proof
Body/Bonnet	Brass or bronze
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, NPT x male HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	Removable key
Manufacturers	Josam "71200", Smith "5610", Wade "W-8604", Woodford "60", Zurn "Z-1315", or approved equal

2.2.03 Wall Hydrants with Vacuum Breaker, VHF-3.

Type	Freeze proof, with vacuum breaker
Body	Brass or bronze
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, NPT x male HPT
Temp. Limitations	32° to 212°F (0° to 100°C)

Valve Operator	Removable key
Manufacturers	Josam "71050", Smith "5609", Wade "W-8620", Woodford "65", Zurn "Z-1310", or approved equal

2.2.04 Yard Hydrants, VHF-4.

Type	Non-freeze, box type
Body	Brass or bronze
Trim	
Seat	Manufacturer’s standard
Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
Box, Cover, Casing	Bronze
End Connection	Threaded, NPT x HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	Removable key
Manufacturers	Josam "Series 71600", Smith "5810/5813", Wade W-8610", Zurn "Z-1360/1365", or approved equal

2.2.05 Post Type Yard Hydrants, VHF-5.

Type	Non-freeze, post type
Body	Brass or bronze
Trim	
Seat	Manufacturer’s standard

Disc	Manufacturer’s standard
Stem	Manufacturer’s standard
Stem Seal	Manufacturer’s standard
End Connection	Threaded, NPT x HPT
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	Removable key
Manufacturers	Josam "Series 71701", Smith "5910/5913", Wade "W-8604", Woodford "60", Zurn "Z-1385/1390", or approved equal

2.3 CURB STOPS.

2.3.01 Curb Stops, VCS-1.

Code	AWWA C800
Type	Straight-through
Body	Brass or bronze
Trim	
Seat	Manufacturer's standard
Plug/Ball	Manufacturer's standard
Stem	Manufacturer's standard
Stem Seal	Manufacturer's standard
End Connection	Threaded
Temp. Limitations	32° to 212°F (0° to 100°C)
Valve Operator	T-handle
Manufacturers	Ford Meter Box "Ford Ball Valve", Hays "Nuseal Curb Stop", Mueller

"Mark II Oriseal", or approved equal

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5 ACCESSORIES.

2.5.01 Extension Stems. Requirements for extension stems and stem guides shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.03 Floor Boxes. Requirements for floor boxes shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.04 Operating Stands. Requirements for operating stands shall be as specified in Master Specification Section 15180,Valve and Gate Actuators.

2.5.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION. Materials furnished under this section will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. When specified herein, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section01180, Equipment, Materials, Parts, and Tools and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated, as in accurate alignment, is free from any undue stress imposed by connecting piping and appurtenances, and has been operated under full load conditions and that is operated satisfactory.

3.2 SCHEDULE. See Schedules 15100-S01 and 15100-S02.

End of Section

SECTION 15101

AWWA BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of AWWA butterfly valves for cold water service as indicated in the Contract Documents and AWWA Butterfly Valve Schedule 15101-S01. All other butterfly valves are covered in Master Specification Section 15092, Industrial Butterfly Valves.

AWWA butterfly valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all butterfly valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C504.

1.2.03 Marking. Supplementing the requirements of Section 6.1 of the governing standard, the country of origin of all castings and an identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

1.2.04 Temporary Number Plates. Each butterfly valve shall be tagged or marked in the factory with the identifying number listed in the AWWA Butterfly Valve Schedule 15101-S01.

1.2.05 Permanent Number Plates. All butterfly valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall

be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Certified copies of test results as specified herein by Section 5 of ANSI/AWWA C504, with an affidavit of compliance as indicated in Section 1.7 of C504, shall be submitted to Engineer before the valves are shipped. Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS. Butterfly valves shall be limited to the manufacturers as specified herein. Sizes and styles for the manufacturers shall be limited as indicated, without exception:

Manufacturer	Acceptable Sizes and Styles
Rodney Hunt	All
Val-Matic	All
Milliken	All
DeZurik	All

Pratt	All
M&H	All

2.2 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of butterfly valves shall conform to the requirements of ANSI/AWWA C504.

Acceptable shop coatings are listed in the following table.

Asphalt Varnish	Fed. Spec. TT-C-494.
Epoxy Enamel (NSF certified systems)	Ameron “Amerlock 400 High-Solids Epoxy Coating”, Carboline “Carbogard 891”, Tnemec “Series N140 Pota-Pox Plus”, or approved equal, immersion service.
Epoxy Enamel (non-NSF certified)	Ameron “Amercoat 385 Epoxy”, Carboline “Carbogard 890”, Tnemec “Series 69 Hi-Build Epoxoline II”, or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Bodies. Valves shall be ductile iron, short-body type except where wafer type is specified in the AWWA Butterfly Valve Schedule 15101-S01. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable.

The valve disc shall be a single casting made of ductile iron with a dome shape.

2.3.02 Flanges. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 µm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (0.017 percent) of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2.3.03 Mechanical Joint Ends. Mechanical joint ends shall be either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11.

2.3.04 Valve Shafts. Valve shafts shall be fabricated of AISI Type 17-4PH stainless steel. The use of shafts having a hexagonal cross section will not be acceptable. Shafts shall be provided with a permanent indicating mark to identify disc position when the actuator is removed or reinstalled.

The connection between the shaft and the disc shall be mechanically secured by means of solid, smooth sided, stainless steel or monel taper pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of set screws, knurled or fluted dowel pins, expansion pins, roll pins, tension pins, spring pins, or other devices instead of the pins specified herein will not be acceptable.

2.3.05 Valve Seats. Acceptable seating surfaces mating with rubber are AISI Type 316 stainless steel, or monel for all valves; bronze for 20 inch (500 mm) and smaller valves.

Seats shall be located on the valve body or disc as required. Valve seat configurations which rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.

The valve seat shall be natural rubber or Buna-N that is certified compliant with NSF 61.

2.3.06 Shaft Seals. The valve shall be provided with a ductile iron stuffing box at the projection of the valve shaft from the valve body. Stuffing boxes for rectangular section packing shall be bushed in an approved manner with bushings made of cast bronze or type 316 stainless steel. Stuffing boxes for “vee” type packing shall be fitted with a cast bronze or type 316 stainless steel bottoming ring.

The stuffing box gland and follower, gland studs and nuts shall be manufactured of cast bronze bronze or type 316 stainless steel. The follower shall be of split construction.

The stuffing box shall be packed with graphited, non-asbestos, rectangular packing or Engineer approved “vee” type packing.

2.3.07 Thrust Bearings. Each valve shall be provided with one or more thrust bearings in accordance with the governing standard. Thrust bearings which are directly exposed to line liquid and which consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable.

2.3.08 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified herein, as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the AWWA Butterfly Valve Schedule 15101-S01.

All 8 inch (200 mm) and larger valves shall have geared actuators.

If valves with an AWWA class designation higher than indicated in the schedule are furnished, actuator torque capabilities shall be increased accordingly and be acceptable to Engineer.

2.4.01 Actuator Sizing. The valve manufacturer shall size the actuator in accordance with AWWA C504, the operating conditions and requirements indicated in the AWWA Butterfly Valve Schedule 15101-S01, and the valve manufacturer's requirements.

For valves 20 inch (500 mm) and smaller, the actuator torque shall be at least 70 percent of the AWWA C504 Table 4 torque for Class 150B. For valves 24 inch (600 mm) and larger, the actuator torque shall be at least 50 percent of the Table 4 torque for the AWWA class valve being provided.

For valves with actuator torque requirements not indicated shall have an actuator torque based on a maximum differential pressure across the valve equal to the valve class and a maximum velocity through the valve of 16 feet per second (4.9 m/s).

Valves with operating stands shall have actuator torques increased by 25 percent. Actuator torques determined by the above requirements shall be increased by any safety factors required by AWWA C504, paragraphs 3.8.6.1 and 3.8.7 or indicated or specified herein.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting. Coal tar shall not be an acceptable coating.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy enamel.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.

Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy Enamel	10 mils (250 µm)
Universal Primer	3 mils (75 µm)

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.05 Torque Tubes. Requirements for torque tubes shall be as indicated in the AWWA Butterfly Valve Schedule 15101-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.06 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.7 SHOP TESTING. Except as modified herein, AWWA butterfly valves shall be tested in accordance with Section 5 of AWWA C504. Each valve shall be performance tested in accordance with Section 5.2.1 and shall be given a leakage test and a hydrostatic test as described in Sections 5.2.2 and 5.2.3.
Each valve shall be leaktight in both directions when closed by the actuator with the maximum pressure applied to the valve.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.
3.2 SCHEDULE. See the Butterfly Valve Schedule 15101-S01.

End of Section

SECTION 15102

ECCENTRIC PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of eccentric plug valves as indicated in the Contract Documents and Eccentric Plug Valve Schedule 15102-S01.

Plug valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Marking. Each valve shall be marked with the manufacturer's name, valve size, and pressure rating, and the country of origin of the body casting. All markings shall be cast on the exterior surface of the valve body. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

1.2.03 Temporary Number Plates. Each eccentric plug valve shall be tagged or marked in the factory with the identifying number listed in the Eccentric Plug Valve Schedule 15102-S01.

1.2.04 Permanent Number Plates. All plug valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate oras indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance withMaster

Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Certified copies of reports covering proof-of-design testing of valves as set forth in Section 5.2 of ANSI/AWWA C504, with an affidavit of compliance as indicated in Section 1.7 of C504, shall be submitted to Engineer before the valves are shipped. Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS. Eccentric plug valves furnished under this section shall be manufactured by DeZurik, Pratt, Milliken, Val-Matic, Clow, or Victaulic, without exception.

2.2 MATERIALS. Materials used in the manufacture of eccentric plug valves shall be as indicated:

Body	Ductile iron, ASTM A536, Grade 65-45-12.
Plug	Ductile iron, ASTM A536, Grade 65-45-12.
Plug Facing	Neoprene or Buna-N, 70 Type A durometer hardness in accordance with ASTM D2240.
Body Seat	Welded nickel overlay.
Upper and Lower Trunnion Bearings	Sleeve type; type 316 stainless steel or bronze.
Upper Thrust Bearing	TFE, Nylatron, or Delrin.

Stem Seal	V-type packing or U-cups, Buna-N or TFE.

Acceptable shop coatings are listed in the following table. Whenindicated on the Contract Documents, epoxy for liquid service shall be as specified in Master Specification Section 09900, Painting rather than as indicated below.

Asphalt Varnish	Fed Spec TT-C-494.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Epoxy	
For Gas Service	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", Plasite "Plasguard 7122", or approved equal.
For Liquid Service	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Body. The valve port area of each valve shall be at least 80 percent of the cross section of the connecting piping for 20 inch (500 mm) and smaller valves and 70 percent for 24 inch (600 mm) and larger valves. Valves shall provide tight shutoff at the rated pressure from either direction. An adjustable closed position plug stop shall be provided.

Each valve body shall be plainly marked to indicate the seat end. The actual length of 10 inch (250 mm) and smaller valves shall be within plus or minus 1/16 inch (1.6 mm) of the theoretical length. The actual length of 12 inch (300 mm) and larger valves shall be within plus or minus 1/8 inch (3 mm) of the theoretical length.

Valve ends shall be compatible with connecting piping. All valves shall have flanged, grooved or mechanical joint ends as indicated in the Eccentric Plug Valve Schedule 15102-S01. Flange diameter and drilling shall be spot faced and conform to ANSI B16.1, Class 125. Flanges shall be flat faced and finished to true plane surfaces within a tolerance limit of 0.005 inch (0.12 mm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of

0.002 inch per foot (0.16 mm per meter) of flange diameter. The degree of smoothness of the flange faces shall be 125 RMS.

Grooved end dimensions shall conform to AWWA C606, Table 5, for rigid joints. When grooved end valves are to be installed in flanged piping, two flange adapters compatible with the connecting piping shall be provided with each valve. Mechanical joint ends shall conform to ANSI/AWWA C111/A21.11.

Valve bodies shall be rated for a working pressure as indicated on the Eccentric Plug Valve Schedule 15102-S01.

2.3.02 Plug. The plug shall be of one-piece construction and shall have a cylindrical or spherical seating surface eccentrically offset from the center of the plug shaft. The interference between the plug face and the body seat, with the plug in the closed position, shall be externally adjustable in the field with the valve in the line under pressure. Plug surfaces shall be faced with a resilient material.

2.3.03 Seats. Seats shall be cast in the body and shall have raised, welded-in nickel overlay not less than 0.050 inch (1.30 mm) thick on all surfaces in contact with the plug face. The overlay shall be at least 90 percent nickel and have a Brinell hardness of 200 or greater.

2.3.04 Stem Seals. The valve shaft shall be sealed by U-cups or by at least four self-adjusting chevron type packing rings.

2.3.05 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified herein, as specified in Master Specification Section 15180, Valve and Gate Actuators and as indicated in the Eccentric Plug Valve Schedule 15102-S01.

Geared actuators shall be used for manually operated valves in the following applications:

1. For all 4 inch (100 mm) and larger buried valves.

2. For all 8 inch (200 mm) and larger valves.

3. For all 6 inch (150 mm) valves in throttling or free discharge applications.

4. For all 6 inch (150 mm) valves where the unseating pressure exceeds

25 psi (170 kPa).

5. For all chainwheel operated valves.

6. For all valves in gas service.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valves and accessories, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	
For Liquid Service	Epoxy.
For Gas Service	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

When specified herein, interior epoxy coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the Eccentric Plug Valve Schedule 15102-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.05 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.7 TESTING. Except as modified herein, eccentric plug valves shall be tested in accordance with Section 5 of AWWA C504. Each valve shall be performance tested in accordance with Section 5.2.1 and shall be given a leakage test and a hydrostatic test as described in Sections 5.2.2 and 5.2.3. The leakage test shall be applied to the seating face of the plug (tending to unseat the plug) at the rated pressure of the valve.

Each valve shall be leaktight in both directions when closed by the actuator with the maximum differential pressure applied to the plug as specified in the Eccentric Plug Valve Schedule 15102-S01.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.2 SCHEDULE. See the Eccentric Plug Valve Schedule 15102-S01.

End of Section

SECTION 15103

AWWA BALL VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of 6 inch (150 mm) and larger AWWA ball valves as indicated in the Contract Documents and AWWA Ball Valve Schedule 15103-S01. Four inch (100 mm) and smaller ball valves are covered in Master Specification Section 15091, Miscellaneous Ball Valves.

AWWA ball valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all ball valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C507.

1.2.03 Temporary Number Plates. Each ball valve shall be tagged or marked in the factory with the identifying number listed in the AWWA Ball Valve Schedule 15103-S01.

1.2.04 Permanent Number Plates. All ball valves shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch [25 mm] high and shall be black baked enamel on anodized aluminum plate or shall be asindicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Certified copies of reports covering proof-of-design testing of valves as set forth in Section 5.2.4.3 of ANSI/AWWA C504, with an affidavit of compliance as indicated in Section 1.3 of C507, shall be submitted to Engineer before the valves are shipped. Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS. Ball valves shall be as manufactured by APCO/Williamette, Valve Technologies, or approved equal.

2.2 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of ball valves shall conform to ANSI/AWWA C507.

Shop Coatings

Epoxy (NSF certified systems.	Ameron "Amerlock 400 High-Solids Epoxy Coating"; Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox plus", or approved equal; immersion service.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Body. Each valve body shall be ductile iron and provided with flanged ends. Flanges shall be flat faced and finished to true plane surfaces within a tolerance of 0.005 inch (0.12 mm). Each flange face shall be perpendicular to the longitudinal axis of the valve, within a maximum angular variation tolerance of 0.002 inch per foot (0.16 mm/m) of flange diameter. Flange faces shall have concentric or spiral serrated finish.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125.

Actual length of valves shall be within plus or minus 1/16 inch (1.6 mm)of the theoretical length.

2.3.02 Ball. Each ball shall be designed so that there will be flow between the ball and body when the ball is in a throttled position and so that substantially all flow is through the ball when in the fully open position.

2.3.03 Seats. The type of seats shall be metal to metal, as specified herein.
For metal-to-metal seated valves, a type 316 stainless steel seat shall be provided on the ball and a monel seat on the valve body. The ball shall be fitted with a type 316 stainless steel sleeve and the ball seat shall be attached to this sleeve by a threaded connection. Valve seats shall be located as specified herein. The seats and the type 316 stainless steel sleeve shall be securely anchored in place.

Contact pressure between seats shall not exceed 1,000 psi (6895 kPa) at an unbalanced head equal to the specified working pressure.

2.3.04 Operating Mechanism. Unless otherwise specified, the basic operating mechanism for each valve shall be of the traveling-nut type and shall consist of (1) a traveling crosshead which will move transversely to the valve shaft, (2) a threaded lead screw engaging corresponding threads in the crosshead, which will move the crosshead when turned by the valve drive unit for manual or electric motor operated valves, and a piston rod with the crosshead directly attached thereto for cylinder operated valves, and (3) a rotator lever, linked to the crosshead, which will impart a rotary motion to the valve shaft. Worm gear type operating mechanisms will also be acceptable for electric motor operated valves. The operator shall have manual stops.

2.3.05 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the AWWA Ball Valve Schedule 15103-S01.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy (NSF 61 certified).
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the AWWA Ball Valve Schedule 15103-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the AWWA Ball Valve Schedule 15103-S01, and as specified in Section Master Specification 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the AWWA Ball Valve Schedule 15103-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators

2.7 PROOF-OF-DESIGN TESTING. Except as modified or supplemented herein, ball valves shall be subject to proof-of-design testing in accordance with Section 5.2.4.3 of ANSI/AWWA C504 titled Rubber-Seated Butterfly Valves. Upon completion of the cycle test, seat leakage of metal-seated valves shall not exceed the rate set forth in Section 5.2.2.1 of ANSI/AWWA C507, and resilient-seated valves shall be droptight.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.
3.2 SCHEDULE. See AWWA Ball Valve Schedule 15103-S01.

End of Section

SECTION 15104

RESILIENT-SEATED GATE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of resilient-seated AWWA gate valves for water service as indicated in the Contract Documents and Resilient-Seated Gate Valve Schedule 15104-S01.

Resilient-seated gate valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all resilient-seated gate valves shall conform to the applicable requirements of ANSI/AWWA C509.

1.2.03 Marking. Supplementing the requirements of Section 7.1 of the governing standard, the name of the country where the valve body was manufactured shall be cast on the exterior of the body. The name of the country where the gate was manufactured shall be molded into the resilient seat material.

1.2.04 Temporary Number Plates. Each resilient-seated gate valve shall be tagged or marked in the factory with the identifying number listed in the Resilient Seated Gate Valve Schedule 15104-S01.

1.2.05 Permanent Number Plates. All gate valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall

be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

All valves shall be tested in accordance with Section 6 of ANSI/AWWA C509. Certified copies of the results of all tests, together with an affidavit of compliance as indicated in Section 1.5, shall be submitted to Engineer before the valves are shipped.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of resilient-seated gate valves shall conform to the requirements of ANSI/AWWA C509.

2.1.01 Bronze Components. All bronze valve components in contact with liquid shall contain less than 15 percent zinc. All aluminum bronze components in contact with liquid shall be heat treated in accordance with Section 2.2 of ANSI/AWWA C504 to inhibit dealuminization.

2.1.02 Gaskets. Gaskets shall be free of asbestos and corrosive ingredients.

2.1.03 Shop Coatings.

Asphalt Varnish Fed Spec TT-C-494.

Epoxy (NSF Certified)	Manufacturer's standard fusion-bonded or liquid epoxy.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.2 VALVE CONSTRUCTION.

2.2.01 Body. Valve shall be fabricated of ductile iron.

2.2.02 Ends. Valve ends shall be compatible with connecting piping and as indicated in the Resilient Seated Gate Valve Schedule 15104-S01. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of ANSI/AWWA C509.

Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 μm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.001 inch per inch (1 μm/mm) of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2.2.03 Stem Seals. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems. The type of stem shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01.

2.2.04 Rotation. The direction of rotation of the handwheel or the wrench nut to open the valve shall be to the left (counterclockwise).

2.2.05. Shop Coating. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. Except as specified below, the valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be coated as follows:

Interior surfaces	Epoxy (NSF certified)
Exterior surfaces of all other valves.	Universal primer.
Polished or machined surfaces.	Rust-preventive compound.

The protective epoxy coating on the interior surfaces of each valve shall be applied in three coats, with a minimum total dry film thickness of 13 mils (325 μm). Alternatively, the manufacturer's standard coating may be used and the interior surfaces of each valve shall be subjected to a nondestructive holiday test in accordance with ASTM G62, Method A, and shall be electrically void-free.

Interior coatings shall comply with AWWA C550. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils (250 μm) or 13 mils (325 μm)where specified herein.
Universal Primer	3 mils (75 μm)

2.3 VALVE ACTUATORS. Requirements for valve actuators shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4 ACCESSORIES.

2.4.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.02 Floor Boxes. Requirements for floor boxes shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.03 Operating Stands. Requirements for operating stands shall be as indicated in the Resilient Seated Gate Valve Schedule 15104-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.04 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves shall be handled and installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.2. SCHEDULE. See the Resilient-Seated Gate Valve Schedule 15104-S01.

End of Section

SECTION 15105

DOUBLE DISC GATE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of 3 inch (75 mm) and larger double disc, parallel seat gate valves for water service as indicated in the Contract Documents and Double Disc Gate Valve Schedule 15105-S01.

Double disc gate valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production and valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and material furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all double disc gate valves shall conform to the applicable requirements of AWWA C500.

1.2.03 Marking. Supplementing the requirements of Section 6.1 of the governing standard, each gate valve shall be marked with the maximum working pressure for which the valve is designed. In addition, the name of the country where the valve body was manufactured shall be cast on the exterior of the body.

1.2.04 Temporary Number Plates. Each double disc gate valve shall be tagged or marked in the factory with the identifying number listed in the Double Disc Gate Valve Schedule 15105-S01.

1.2.05 Permanent Number Plates. All gate valves, except buried or submerged valves, shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall

be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

Certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components.

All valves shall be tested in accordance with Section 5.2 of AWWA C500. Certified copies of the results of all tests, together with an affidavit of compliance as indicated in Section 1.4, shall be submitted to Engineer before the valves are shipped. Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of double disc gate valves shall conform to the requirements of ANSI/AWWA C500.

2.1.01 Bronze Components. All bronze valve components in contact with liquid shall contain less than 15 percent zinc. All aluminum bronze components in contact with liquid shall be heat treated in accordance with Section 2.2 of ANSI/AWWA C504 to inhibit dealuminization.

2.1.02 Gaskets. Gaskets shall be free of asbestos and corrosive ingredients.

2.1.03 Shop Coatings.

Epoxy Enamel (NSF certified)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal; immersion service.

Epoxy Enamel (non-NSF certified)	Ameron "Amerlock 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.2 VALVE CONSTRUCTION.

2.2.01 Body. Valve shall be fabricated of ductile iron.

2.2.02 Ends. Valve ends shall be compatible with connecting piping and as indicated in the Double Disc Gate Valve Schedule 15105-S01. Except as modified or supplemented herein, the ends shall conform to the applicable requirements of ANSI/AWWA C500.

Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch (125 µm). The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (165 µm/m) of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2.2.03 Stem Seals. Stuffing box stem seals shall be provided for all gate valves with rising stems (outside screw-and-yoke type). O-ring stem seals shall be provided for all buried gate valves, and for all gate valves with non-rising stems. The type of stem shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01.

2.2.04 Rotation. The direction of rotation of the handwheel or wrench nut to open the valve shall be to the right (clockwise).

2.2.05 Bypasses. All 16 inch (400 mm) and larger gate valves shall be provided with a bypass and a bypass valve. Bypasses and bypass valves shall comply with Section 3.20 and Table 8 of the governing standard.

2.2.06 Gearing. All 16 inch (400 mm) and larger gate valves shall be provided with gears and gear cases as indicated in the Double Disc Gate Valve Schedule 15105-

S01. Gears and gear cases shall comply with Sections 3.17 and 3.18 and Table 7 of the governing standard.

2.2.07 Internal Rollers and Tracks. All 16 inch (400 mm) and larger valves installed in horizontal piping with the stem oriented horizontally shall be equipped with internal rollers and tracks, as indicated in the Double Disc Gate Valve Schedule 15105-S01.

2.2.08 Shop Coating. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Master Specification Section 09900, Painting.

Surfaces shall be coated as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy enamel (NSF certified for potable water service).
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.
Actuators and Accessories	Universal primer.

Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness

Epoxy Enamel	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.3 VALVE ACTUATORS. Requirements for valve actuators shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4 ACCESSORIES.

2.4.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.02 Floor Boxes. Requirements for floor boxes shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.03 Operating Stands. Requirements for operating stands shall be as indicated in the Double Disc Gate Valve Schedule 15105-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.4.04 Valve Boxes. Requirements for valve boxes shall be as indicated in the DWSD standard details.

All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

PART 3 - EXECUTION

3.1 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.2 SCHEDULE. See the Double Disc Gate Valve Schedule 15105-S01.

End of Section

SECTION 15106

CONE VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of cone valves for the services indicated in the Contract Documents and Cone Valve Schedule 15106-S01.

Cone valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Temporary Number Plates. Each cone valve shall be tagged or marked in the factory with the identifying number listed in the Cone Valve Schedule 15106-S01.

1.2.03 Permanent Number Plates. All cone valves shall be provided with a permanent number plate. The location of number plates and the method of fastening shall be acceptable to Engineer. Numerals shall be at least 1 inch (25 mm) high and shall be black baked enamel on anodized aluminum plate or as indicated in the Contract Documents.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of all ductile iron valve components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

Fluid diagrams for all hydraulic systems shall be submitted. Diagrams shall be drawn using fluid power symbols approved by the American National Standards Institute, Inc., or the manufacturer's standard set of symbols if these symbols adequately and clearly explain the operation of the various components.

In addition, the following drawings shall be submitted before fabrication of the valve control equipment for the pump check valves:

> Curve plotting "Area of Opening in Percent of Full Opening" versus "Plug Rotation in Degrees".
>
> Curve plotting "Area of Opening in Percent of Full Opening" versus "Time of Valve Closure" for normal closing.
>
> Curve plotting "Area of Opening in Percent of Full Opening" versus "Time of Valve Closure" for emergency closing.

When requested by the Engineer, certified copies of physical and chemical test results shall be submitted for the materials of construction of valve components. Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

Contractor shall submit results of all pressure and leakage testing.

PART 2 - PRODUCTS

2.1 <u>ACCEPTABLE PRODUCTS</u>. Cone valves shall be manufactured by Rodney Hunt, American Valve (Pennsylvania), or approved equal.

2.2 <u>MATERIALS</u>. Materials used in the manufacture of the cone valve as furnished, and of all valve accessories, appurtenances, and control equipment and devices, shall be new and the best and most suitable for the purpose intended in each case, the selection of each such material being based on strength, ductility, durability, and other basic properties in accordance with the best current engineering practice. Materials shall conform to the latest applicable standards of the American Society for Testing and Materials.

Materials used in the manufacture of the cone valve shall be as follows:

Body	Ductile iron, ASTM A536 Grade 65-45-12.
Plug	Ductile iron, ASTM A536, Grade 65-45-12.
Body Seats	Monel.
Plug Seats	Monel.
Bearings	Bronze.
Plug Shaft	Stainless steel, AISI Type 17-4PH w/minimum tensile strength of 80,000 psi.
Operating Mechanism	Cast steel, ASTM A27; or ductile iron, ASTM A536.
Shaft Packing	Graphite packing with split lantern ring/gland. Provide special tools necessary for packing replacement.
Shop Coatings	
Epoxy Enamel	NSF certified systems; Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Universal Primer	Universal Rust-Inhibitive Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 888 Primer," or Tnemec Series N27 S.T. Typoxy.
Rust-Preventive Compound	Houghton "Rust Veto 344".

All materials subject to rubbing contact shall be of different hardness to prevent galling. Difference in hardness between the two surfaces shall be at least 125 Brinell.

2.3 VALVE CONSTRUCTION.

2.3.01 Valve Body. The body of the valve shall be ductile iron and shall have flanged inlet and outlet waterway openings and a flanged opening for insertion or removal of the valve plug.

Both inlet and outlet ends of the valve body shall be provided with seat rings fused into the body metal, with the seat faces raised above adjacent body surfaces by a sufficient amount to assure free operation of the valve plug regardless of any encrustations on interior body surfaces.

Each valve shall be provided with four NPT taps with solid brass plugs, two located on each side of the valve. The size of the taps shall be determined by the Owner based on the size of the valve.

2-3.02 Flanges. The valve shall be provided with end flanges conforming to ANSI/ASME B16.1, Class 250.

Flanges shall be flat faced and finished to true plane surfaces within a tolerance limit of 0.005 inch. Each finished face shall be perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter.

Flanges shall be drilled and spot faced per ANSI B16.1, Class 125. The degree of smoothness of the flange faces shall be 125 RMS.

2-3.03 Plug. The plug shall be in the form of a frustrum of a cone, with a clear circular-section waterway. The plug shall rotate on large diameter end trunnions made of magnesium bronze with a tensile strength of 70,000 psi, and shall be provided with bronze bearing sleeves operating in bronze-bushed bearings in both valve body and valve-head cover. The clearances between bearing sleeves and the bearings shall not exceed 0.008 inches. The maximum allowable unit bearing stress shall not exceed 3,000 psi. The valve operating shaft shall be provided with either a hard bronze sleeve or a chrome overlay where it passes through the valve-head cover stuffing box.

The plug shall be provided with four seat rings fused into the plug metal, one each around the inlet and the outlet plug openings, and the other two placed at right angles thereon so as to cut off the flow when the valve is in a closed position. The plug and seats shall be designed for only an axial motion for unwedging the seated pair of the plug seats from the body seats and of a rotary motion for turning the plug 90 degrees and aligning the second pair of seats in the plug with the body seats, followed only by axial motion during seating. Seats shall not be in contact with any part of the valve at any time during rotation of the plug. Body seats and their mating plug seats shall be machined to close tolerances, so as to fully mate to reduce wear and minimize leakage when the cone pump check valve is fully opened or closed.

The plug seats shall have a minimum thickness of 0.090 inches after fusing and machining.

2.3.04 Valve-Head Cover. The valve shall be provided with a valve-head cover casting which will (a) close the flanged head opening in the valve body, (b) support the outer plug trunnion and attached shaft, and (c) support the valve operating mechanism and mechanism housing. The valve head cover shall be arched in the center to allow water from the packing gland or other external source to drain freely off the valve. The valve-head cover shall make a registered connection with the valve body and shall be provided with a bronze-bushed bearing, shaft stuffing box, split bronze packing gland, suitable graphite packing, and four jacking bolts equally spaced around the perimeter for removal. Head bolts, studs, and nuts shall be of silicon bronze. Reference match marks shall be provided on both body and valve-head cover to ensure proper assembly.

The stuffing box shall have sufficient depth for the graphite packing and to contain a portion of the gland. The packing shall be replaceable without removing the valve actuator. The gland shall be bronze, split, drilled, threaded and pinned. It shall be easily accessible, adjustable via bronze studs and double nuts with one nut being a locking nut. The valve actuator shall not be used to retain the shaft seal.

2.3.05 Operating Mechanisms. The basic valve operating mechanism shall consist of (a) crosshead which will move in a straight line between parallel guide rods transversely to the plug shaft, (b) a piston rod which will transmit an operating force from the drive unit to the crosshead, (c) a lift lever which will impart a rotary motion to the plug shaft. The operating mechanism shall provide for axial adjustment of the plug to compensate for any wear that may develop. The plug operating shaft shall be of sufficient strength to withstand any stresses to which it may be subjected under the most adverse operating conditions. Pipe stops are required in the open position.

Valve operation shall be such that 10 percent opening area of the plug waterway will be obtained when the crosshead travels between 45 and 55 percent of its total linear movement.

Crosshead, lift nut and other parts of the operating mechanism shall be greasable from the outside of the mechanism housing.

The valve operating mechanism shall be totally enclosed in a suitable housing with a removable cover which will permit inspection, adjustment, and repair of the operating mechanism.

2.3.06 Valve Position Indicators. An indicating pointer, attached to a plug shaft extension through and operating over an indicator plate mounted on the operating mechanism housing cover, shall be provided to indicate the position of the plug opening relative to the body seat openings. The indicating pointer shall be both bolted and pinned to the plug shaft extension to ensure alignment.

Indicator plates shall be graduated to show percentages of both projected port area and plug rotation.

2.3.07 Rotation. The direction of rotation of the handwheel to open the valve shall be to the left (counterclockwise).

2.3.08 Valve Base. Cone valves shall be provided with a base or pedestal for support. Cone valves shall be supported upon a steel bearing plate anchored into a concrete support as indicated on the Drawings. Contact surfaces of valve body and bearing plate shall have milled finishes, and the valve shall be free to move upon the bearing plate. Bolting of the valve to base will not be acceptable.

2.4 VALVE ACTUATORS. Requirements for valve actuators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators, and as indicated in the Cone Valve Schedule 15106-S01.

2.5 SHOP COATING. All interior and exterior ferrous metal surfaces of valves and accessories shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in Master Specification Section 09900, Painting.

Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

Interior coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy Enamel	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.6 ACCESSORIES.

2.6.01 Extension Stems. Requirements for extension stems and stem guides shall be as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.02 Position Indicators. Requirements for position indicators shall be as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.03 Floor Boxes. Requirements for floor boxes shall be as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

2.6.04 Operating Stands. Requirements for operating stands shall be as indicated in the Cone Valve Schedule 15106-S01, and as specified in Master Specification Section 15180, Valve and Gate Actuators.

PART 3 - EXECUTION

3.1 HYDROSTATIC TESTS. Each valve shall be fully assembled in the shop prior to testing. Test heads shall be bolted to each waterway flange and, with the plug in a partially open position, each valve shall be tested hydrostatically at a test pressure equal to 150 psi greater than the valve working pressure. This test pressure shall be maintained for 30 minutes, and the valve shall show no evidence of structural failure, seeps, or leakage at any point.

The valve shall also be tested for leakage, with one test head removed and the plug closed. A test pressure equal to the valve working pressure shall be applied and maintained for 15 minutes, during which time the leakage through the valve shall not exceed 0.15 ounce per minute per inch of valve waterway diameter. The test should then be repeated with the pressure applied to the opposite side of the valve.

After complete assembly, the valve shall be opened and closed at least twice.

Cone valve operator controls shall be shop tested for proper operation prior to shipment.

3-1.01 Witness Testing. Representatives from both the Owner and the Engineer will witness shop tests of all cone valves.

All testing equipment used will be inspected. The Contractor shall notify the Engineer at least 14 days in advance of the time that the shop test will be conducted. All valves to be tested shall be tested during one trip to the factory of a duration acceptable to the Engineer.

3.2 INSTALLATION. Valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

3.3 SCHEDULE. See Cone Valve Schedule 15106-S01.

End of Section

SECTION 15108

AIR RELEASE AND COMBINATION AIR VALVES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of air release and combination air valves as indicated in the Contract Documents and Air Release and Combination Air Valve Schedule 15108-S01.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Governing Standard. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable requirements of AWWA C512.

1.2.03 Permanent Number Plates. Each valve shall be provided with a number plate, with at least 1 inch (25 mm) high black baked enamel numerals on anodized aluminum plate. The location of number plates and the method of attachment shall be acceptable to Engineer.

1.3 SUBMITTALS. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.
Manufacturer shall submit certification that each valve and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of valve.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS.

Air release valves with operating pressures of 150 psi (1000 kPa) or less shall be Apco/Valve and Primer "No. 200", GA Industries "Figure 920m", Multiplex "Crispin Type N", Val-Matic "No. 38", or approved equal.

Air release valves with operating pressures greater than 150 psi (1000 kPa) shall be Apco/Valve and Primer "No. 200A", GA Industries "Figure 920H", Multiplex "Crispin Type N", Val-Matic "No. 38", or approved equal.

Three inch (75 mm) and smaller combination air valves shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", Val-Matic "Combination Air Valves", or approved equal.

Four inch (100 mm) and larger combination air valves shall consist of an air and vacuum valve with an externally mounted air release valve. The valves shall be Apco/Valve and Primer "Custom Combination Air Valves", GA Industries "Figure 950 Kinetic Custom Combination Air Valves", Multiplex "Crispin Dual Air Valves", Val-Matic "Dual Body Combination Air Valves", or approved equal.

Three inch (75 mm) and smaller air release and vacuum relief valves for vertical diffusion vane pumps shall be of the kinetic energy type with a valve assembly which functions as both an air release and a vacuum relief valve. The exhaust from the valve shall be provided with a throttling device for field adjusting the air flow rate. The valves shall be Apco/Valve and Primer "Series 140DAT Air Valves for Vertical Turbine Pumps", GA Industries "Figure 933 Kinetic Air/Vacuum Valve", Multiplex "Crispin Deep Well Air Valve", or approved equal. The discharge from the valve shall be provided with a threaded NPT connection.

Four inch (100 mm) and larger air release and vacuum relief valves for vertical diffusion vane pumps shall be of the kinetic energy type with a valve assembly which functions as both an air release and a vacuum relief valve. The valve shall be provided with a surge check valve on the valve inlet. The valves shall be Apco/Valve and Primer "Series 1900 Air Valves for Vertical Turbine Pumps", GA Industries "Figure 931 Slow-Closing Kinetic Air/Vacuum Valve", Multiplex "Crispin Air & Vacuum Valve with Surge Check Valve", or approved equal. The discharge from the valve shall be provided with a flanged connection.

2.2 MATERIALS. Except as modified or supplemented herein, materials of construction shall comply with the governing standard. The use of stressed thermoplastic components will not be acceptable.

Valve Trim	Bronze or type 316 stainless steel.

Float	Type 316 stainless steel.
Shop Coatings	
Epoxy (NSF Certified)	Carboline "Carboguard 891" Tnemec "Series N140 Pota-Pox Plus, or approved equal."
Universal Primer	As recommended by the manufacturer and compatible with the field coating.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 SHOP COATING. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified inMaster Specification Section 09900, Painting.

Surfaces shall be painted as indicated:

Interior Surfaces	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

Interior epoxy coatings shall comply with AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils (250 μm)
Universal Primer	3 mils (75 μm)

2.4 SHUTOFF VALVES. A shutoff valve shall be provided in the piping leading to each air release valve and combination air valve. Each 4 inch (100 mm) and larger combination air valve shall be provided with a shutoff valve between the air and vacuum valve and the air release valve.

PART 3 - EXECUTION

3.1 INSTALLATION. Air release and combination air valves will be installed in accordance with Master Specification Section 15010, Valve Installation.

3.2 SCHEDULE. See Air Release and Combination Air Valve Schedule 15108-S01.

End of Section

SECTION 15130

INDICATING DEVICES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of line-mounted, local indicating devices and accessories.

Remote indicating devices or transmitters are covered in Master Specification Section 17500, Instrumentation General Requirements. Temperature wells (thermowells) are covered in Master Specification Section 15020, Miscellaneous Piping and Accessories Installation. Devices to be furnished by an equipment supplier, either with an item of equipment or as a component of an equipment package, are covered in the applicable equipment section.

Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

1.2.01 Coordination. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all pressure gauges shall conform to the requirements of ANSI/ASME B40.1.

1.2.04 Temporary Number Plates. Each device shall be factory tagged or marked to identify the device by type and number, as indicated.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete drawings or catalog cuts, together with detailed specifications and data covering materials used, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance withMaster Specification Section 01160, Training and Operation & Maintenance Manuals.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with therequirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the specified conditions as indicated in the Contract Documents.

2.2 CONSTRUCTION.

2.2.01 Pressure Indicators. Pressure indicators shall be dial type with rotary geared movement and adjustable pointer.

The dial shall be white background with black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees (3.5 rad) nor more than 270 degrees (4.7 rad) or arc.

Pressure indicators shall be as manufactured by 3D Instruments, or approved equal.

2.2.02 Temperature Indicators.

2.2.02.01 Bi-Metal. Bi-metal temperature indicators shall be hermetically sealed type with external zero adjustment. Indicators shall be furnished with angularly adjustable frame to permit positioning of the dial to accommodate easy viewing.

2.2.02.02 Filled Temperature Indicators. Gas-filled temperature indicators shall be furnished complete with dial indicator, armored capillary tubing and bulb or temperature sensor. Direct mounted indicators shall have an angularly adjustable frame to permit positioning of the dial to accommodate easy viewing.

2.2.03 Sight Flow Indicators. Sight flow indicators shall be provided as indicated in the Contract Documents to provide a visual indication of flow within a pipe. Sight flow indicators shall be of the double window type.

2.2.04 Rotameters. Rotameters (variable area flow meters) shall be provided as indicated in the Contract Documents. Bypass rotameters shall be furnished complete with both a line orifice plate and a range orifice. The range orifice shall be designed to limit flow through the rotameter to within the range of the rotameter.

2.2.05 Orifice Plates and Flanges. Orifice plates shall be ISA standard plates with concentric bore to the nearest 1/8 inch (3 mm) for the flow range specified. Flanges for the orifice plate will be furnished with jackscrews for installing and removing the orifice plate. Tab or coupon shall be provided that indicates the size of the orifice plate.

2.3 ACCESSORIES.

2.3.01 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 INSPECTION. All equipment and accessories shall be inspected for damage and cleanliness before being installed. Any items damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by the Contractor. Such equipment shall be segregated from the undamaged/clean items and shall be inspected and approved by the Owner or his representative before its use.

3.2 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with Master Specification Section 15020, Miscellaneous Piping and Accessories Installation.

All indicating devices shall be installed so they can be easily read from floor/platform level and are readily accessible for maintenance and service.

3.2.01 Pressure Indicators. All pressure indicators installed in steam and any other elevated temperature service shall be protected with a thermal isolator (pigtail). Angle style pigtails shall be used for gauges connected to vertical surfaces. Straight-style pigtails shall be used for gauges connected to horizontal surfaces. Pigtails are not to be insulated.

An isolation valve shall be installed at each pipe branch to a pressure indictor except where in-line, flow-through diaphragm seal gauge isolators are utilized. The valve shall be suitable for the line pressure and temperature and shall allow removal of the indicator while the monitored line is in operation.

3.2.02 Temperature Indicators. All temperature indicators shall be installed in temperature wells (thermowells). Filled system indicator dials shall be mounted on a column or floor support approximately 5 feet (1.5 m) above the viewing floor level. Spare capillary shall be neatly coiled and tied.

3.2.03 Sight Flow Indicators. Flapper type sight flow indicators in horizontal piping shall be installed with the flapper hinge at the top of the pipe.

3.2.04 Rotameters. Rotameters shall be installed between 3 and 6 feet (0.9 and 1.8 m) above the viewing floor level. Rotameters shall be installed with flow vertical upwards

Isolation valves shall be installed in the rotameter inlet and outlet piping near the orifice flanges for bypass rotameters. The isolation valves shall allow removal of the rotameter while the monitored line remains in operation. Unions or flanges shall be provided within 2 feet (0.6 m) of the rotameter to facilitate removal.

3.2.05 Orifice Plates and Flanges. Orifice flanges in horizontal piping runs shall be installed so that the orifice taps are located on the vertical centerline at the top of the pipe for gas service and on the horizontal centerline for liquid and steam service.

Orifice plates and flanges shall be installed with the minimum upstream and downstream lengths of unobstructed pipe as indicated on the drawings.

End of Section

SECTION 15140

PIPE SUPPORTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of pipe hangers, brackets, and supports. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories. This section also covers the spacing of expansion joints in piping systems. Expansion joint products and materials are covered in the respective piping sections.

Concrete and fabricated steel supports shall be as indicated in the Contract Documents.

1.2 GENERAL. In certain locations, pipe supports, anchors, and expansion joints have been indicated on the drawings, but no attempt has been made to indicate every pipe support, anchor, and expansion joint. It shall be Contractor's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to anchor all piping, in accordance with the requirements specified herein. Additional pipe supports may be required adjacent to expansion joints, couplings, or valves.

All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports.

Pipe supports and expansion joints are not required in buried piping, but concrete blocking or other suitable anchorage shall be provided as indicated in theContract Documents.

Piping support system components shall comply with specified piping code requirements.

1.2.01 Abbreviations. Reference to standards and organizations in this section shall be as indicated by the following designations.

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASTM	American Society of Testing and Materials
MSS	Manufacturers Standardization Society of Value and Fitting

Industry

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.3 SUBMITTALS. Complete data and catalog cuts or drawings covering fabricated pipe supports, fabricated inserts, and stainless steel, galvanized, and copper- and plastic-coated pipe supports shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Data shall include a listing of the intended use and general location of each item submitted.

PART 2 - PRODUCTS

2.1 MATERIALS. Unless otherwise indicated, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the structural and miscellaneous metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.

Unless otherwise specified or indicated on the drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.

Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 12 inches (300 mm) in length.

Unless otherwise acceptable to Engineer, the use of supports which rely on stressed thermoplastic components to support the pipe will not be acceptable.

Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Supports for brass or copper pipe or tubing shall be copper plated. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated.

Stainless steel supports shall be furnished, and shall be AISI Type 304 or 316 stainless steel. Stainless steel supports fabricated by welding shall be AISI Type 304L or 316L.

Hot-dip galvanized supports shall be furnished and shall be in accordance with ASTM A153 and A385.

Pipe support types and application shall comply with Table 1.

PART 3 - EXECUTION

3.1 APPLICATION. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Expansion anchors shall be used to fasten supports to existing concrete and masonry.

Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as specified to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as needed to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.

When expansion joints are necessary, pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required where mechanical couplings are permitted as expansion joints. Guides shall be located on both sides of expansion joints, except where anchors are adjacent to the joint. Unless otherwise indicated on the drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for support. Pipe guides shall be provided at locations as recommended by the manufacturer.

Pipe supports for insulated cold piping systems shall be sized for the outside diameter of the insulated pipe, and an insulation protection shield shall be installed between the support and the insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields for piping larger than 2 inches (50 mm) or when needed to prevent crushing of the insulation. Inserts shall be of the same thickness as the adjacent insulation and shall be vapor sealed.

Insulated hot piping systems shall be supported by clevises, clamps, support saddles, or rollers. Pipe clamps shall be attached directly to the pipe. Support saddles and rollers shall be sized for the outside diameter of the insulated pipe, and an insulation protection saddle shall be installed at the support.

When supports for the FRP piping systems are in contact with less than 180 degrees of the pipe surface or when the width of the support is less than one-third the nominal pipe diameter (4 inches (100 mm] minimum), an FRP or steel saddle, shaped to the outside diameter of the pipe, shall be bonded to at least the bottom 120 degrees of the pipe.

3.2 TYPES OF SUPPORTS. The specific products for pipe supports shall be as indicated in Table 1 for the specified type and size of support.

TABLE 1 - TYPES OF SUPPORTS		
Description and Service	Type	
	MSS SP 69 (Note 1)	Other
Hangers		
2-1/2 inch (63 mm) and smaller pipe		
For hot and cold insulating piping		
Clevis	1	B-Line "B3100" or Grinnell "260"
Other services		
J-style	5	B-Line "B3690", Grinnell "67", or Unistrut "J Hanger".
Clevis	1	B-Line "B3104" or Grinnell "65"
3 Through 10 inch (75 through 250 mm) pipe		
For hot insulated piping		

TABLE 1 - TYPES OF SUPPORTS		
Description and Service	Type	
	MSS SP 69 (Note 1)	Other
Double bolt	3	B-Line "B3144" or Grinnell "295"
For cold insulated piping		
Clevis	1	B-Line "B3100" or Grinnell "260"
For uninsulated cold piping		
Clamp	4	B-Line "3140" or Grinnell "212"
Clevis	1	B-Line "B3100" or Grinnell "260"
Other services		
Clevis	1	B-Line "B3100" or Grinnell "260" for steel pipe; B-Line "B3102" or Grinnell "590" for cast iron pipe.
12 inch (300 mm) pipe		
Clevis or saddle	1	See drawings.
14 inch (350 mm) and larger pipe		
Saddle	--	See drawings
Concrete Inserts, Steel		

TABLE 1 - TYPES OF SUPPORTS			
Description and Service		Type	
		MSS SP 69 (Note 1)	Other
	12 inch (300 mm) and smaller pipe	18	Channel 12 ga (2.66 mm thick) galv, 1-5/8 by 1-3/8 inches (41.3 by 34.9 mm), min. 8 inches (200 mm) long, anchor lugs on 4 inch (100 mm) centers, at least three lugs, end caps, and filler strip.
	14 inch (350 mm) and larger pipe, fabricated insert, except as noted	--	See drawings.
Beam Clamps, Malleable Iron or Steel, 12 inch (300 mm) and smaller pipe		21	B-Line "3050" and "3055" or Grinnell "133" and "134"
		28, 29	Grinnell "292"
		30	B-Line "3054" or Grinnell "228"
Side Beam Bracket		34	B-Line "B3062" or Grinnell "202"
Wall Supports and Frames, Steel, 12 inch (300 mm) and smaller pipe (Note 2)			
	Brackets	32	B-Line "B3066" or Grinnell "195"
		33	B-Line "B3067" or Grinnell "199"

TABLE 1 - TYPES OF SUPPORTS			
Description and Service		Type	
		MSS SP 69 (Note 1)	Other
	Prefabricated channels	--	12 ga (2.66 mm thick), galv, 1-5/8 inches (41.3 by 41.3 mm), with suitable brackets and pipe clamps.
	Offset pipe clamp, 1-1/2 inch (38) mm and smaller pipe	--	Galv, 1-1/4 by 3/16 inch (32 by 4.7 mm) steel, with 3/8 inch (9.5 mm) bolts
	Offset pipe clamp, 2 to 3-1/2 inch (50 to 88 mm) pipe	--	Galv, 1-1/4 by 1/4 inch (32 by 6 mm) steel, with 3/8 inch (9.5 mm) bolts
Floor Supports, Steel or Cast Iron			
	6 inch (150 mm) and smaller pipe	37 (with base)	B-Line "B3090" or Grinnell "259"
	8 through 24 inch (200 to 600 mm) pipe	38	B-Line "B3093" or Grinnell "264"
Pipe Alignment Guides		--	B-Line "B3281" Through "B3287" or Grinnell "255"
Turnbuckles Steel		13	B- Line "B3202" or Grinnell "230"
Hanger Rods, Carbon Steel, Threaded Both Ends, 3/8 inch (10 mm) minimum size		--	B - Line "B3205" or Grinnell "140"
Weldness Eye Nut, steel		17	B - Line "B3200" or Grinnell "290".

TABLE 1 - TYPES OF SUPPORTS		
Description and Service	Type	
	MSS SP 69 (Note 1)	Other
Insulation Protection Saddle	39	B - Line "B3160 Series" or Grinnell "160 Series"
Insulation Protection Shield	40	B - Line "B3151" or Grinnell "167"

Table 1 Notes:

1. MSS SP-69 supports and hangers are illustrated on Figure 1-15140.
2. Pipe clamps or other devices which rely on the application of a clamping force to the supported pipe in order to maintain the clamp position or location in a prefabricated channel or track will not be acceptable for use with nonmetallic pipe or tubing.

3.3 <u>SUPPORT SPACINGS</u>. Pipe supports and expansion joints shall be spaced in accordance with Tables 2, 3, 4, and 5. The types of pipes to be supported are as indicatbed. Table 2 covers spacings for the standard operating conditions specified for each pipe material. Tables 3 and 4 cover PVC and FRP pipe spacings where operating conditions are in excess of the temperature and specific gravity requirements covered in Table 2. Table 5 covers PVC and FRP pipe which carries air or liquids with a specific gravity other than 1.0.

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
Cast iron		15 (4.5)	80 (24.4)	80 (24.4)	Note 6
Cast iron, glass-lined		12 (3.6)	80 (24.4)	80 [(24.4)	Note 6
Steel, for hot water heating					
	1-1/4 inch (31 mm) and smaller	7 (2.1)	30 (9.1)	100 (30.5)	Note 3
	1-1/2 to 4 inch (38 to 100 mm)	10 (3.0)	30 (9.1)	100 (30.5)	Note 3
	Over 4 inch (100 mm)	15 (4.5)	30 (9.1)	100 (30.5)	Note 3
Steel, for other services					
	1-1/4 inch (31 mm) and smaller	7 (2.1)	30 (9.1)	100 (30.5)	Note 3
	1-1/2 to 4 inch (38 to 100 mm)	10 (3.0)	30 (9.1)	100 (30.5)	Note 3
	Over 4 inch (100 mm)	15 (4.5)	80 (24.4)	80 (24.4)	Note 6
Stainless steel					

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/4 inch (31 mm) and smaller	7 (2.1)	30 (9.1)	100 (30.5)	Note 3
	1-1/2 to 4 inch (38 to 100 mm)	10 (3.0)	30 (9.1)	100 (30.5)	Note 3
	Over 4 inch (100 mm)	15 (4.5)	80 (24.4)	80 (24.5)	Note 3
Copper, for hot water					
	1 inch (25 mm) and smaller	5 (1.5)	20 (6.1)	100 (30.5)	Note 3
	Over 1 inch (25 mm)	7 (2.1)	20 (6.1)	100 (30.5)	Note 3
Copper, for other services					
	1 inch (25 mm) and smaller	5 (1.5)	--	--	Note 7
	Over 1 inch (25 mm)	7 (2.1)	50 (15.2)	100 (30.5)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
PVC, Schedule 80, for alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution at a maximum temperature of 100°F (38°C).					
	1/8 and 1/4 inch (3 and 6 mm)	Continuous Support	20 (6.1)	60 (18.3)	Note 3
	1/2 inch (13 mm)	3-1/2 (1)	20 (6.1)	60 (18.3)	Note 3
	3/4 inch (19 mm)	4 (1.2)	20 (6.1)	60 (18.3)	Note 3
	1 and 1-1/4 inch (25 and 31 mm)	4-1/2 (1.3)	20 (6.1)	60 (18.3)	Note 3
	1-1/2 and 2 inch (38 and 50 mm)	5 (1.5)	20 (6.1)	60 (18.3)	Note 3
	2-1/2 inch (63 mm)	5-1/2 (1.6)	20 (6.1)	60 (18.3)	Note 3
	3 inch (75 mm)	6-1/2 (1.9)	20 (6.1)	60 (18.3)	Note 3
	4 inch (100 mm)	7 (2.1)	20 (6.1)	60 (18.3)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	6 inch (150 mm)	8 (2.4)	20 (6.1)	60 (18.3)	Note 3
	8 inch (200 mm)	9 (2.7)	20 (6.1)	60 (18.3)	Note 3
	10 inch (250 mm)	9-1/2 (2.9)	20 (6.1)	60 (18.3)	Note 3
	12 inch (300 mm)	10 (3.0)	20 (6.1)	60 (18.3)	Note 3
PVC, Schedule 80, for other services at a maximum temperature of 100°F (38°C) and a maximum specific gravity of 1.0.					
	1/8 and 1/4 inch (3 and 6 mm)	Continuous Support	20 (6.1)	60 (18.3)	Note 3
	1/2 inch (13 mm)	4 (1.2)	20 (6.1)	60 (18.3)	Note 3
	3/4 inch (19 mm)	4-1/2 (1.3)	20 (6.1)	60 (18.3)	Note 3
	1 and 1-1/4 inch (25 and 31 mm)	5 (1.5)	20 (6.1)	60 (18.3)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/2 and 2 inch (38 and 50 mm)	5-1/2 (1.6)	20 (6.1)	60 (18.3)	Note 3
	2-1/2 inch (63 mm)	6 (1.8)	20 (6.1)	60 (18.3)	Note 3
	3 inch (75 mm)	7 (2.1)	20 (6.1)	60 (18.3)	Note 3
	4 inch (100 mm)	7-1/2 (2.3)	20 (6.1)	60 (18.3)	Note 3
	6 inch (150 mm)	8-1/2 (2.6)	20 (6.1)	60 (18.3)	Note 3
	8 inch (200 mm)	9-1/2 (2.8)	20 (6.1)	60 (18.3)	Note 3
	10 inch (250 mm)	10 (3.0)	20 (6.1)	60 (18.3)	Note 3
	12 inch (300 mm)	11 (3.3)	20 (6.1)	60 (18.3)	Note 3
FRP, for double containment and single wall pressure pipe at a temperature of 150°F (66°C).					
	1 inch (25 mm)	3-1/2 (1)	60 (18.3)	100 (30.5)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/2 inch (38 mm)	4 (1.2)	60 (18.3)	100 (30.5)	Note 3
	2 inch (50 mm)	5 (1.5)	60 (18.3)	100 (30.5)	Note 3
	3 inch (75 mm)	5-1/2 (1.6)	60 (18.3)	100 (30.5)	Note 3
	4 inch (100 mm)	6 (1.8)	40 (12.2)	100 (30.5)	Note 3
	6 inch (150 mm)	7 (2.1)	40 (12.2)	100 (30.5)	Note 3
	8 inch (200 mm)	8 (2.4)	40 (12.2)	100 (30.5)	Note 3
	10 inch (250 mm)	8-1/2 (2.6)	40 (12.2)	100 (30.5)	Note 3
	12 inch (300 mm) and larger	9 (2.7)	40 (12.2)	100 (30.5)	Note 3
FRP, for low pressure and odor control pipe at a maximum temperature of 150°F (66°C) and a maximum specific gravity of 1.0.					
	1 inch (25 mm)	4 (1.2)	60 (18.3)	100 (30.5)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES					
Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	1-1/2 inch (38 mm)	4-1/2 (1.3)	60 (18.3)	100 (30.5)	Note 3
	2 inch (50 mm)	5-1/2 (1.6)	60 (18.3)	100 (30.5)	Note 3
	3 inch (76 mm)	6 (1.8)	60 (18.3)	100 (30.5)	Note 3
	4 inch (100 mm)	6-1/2 (2)	40 (12.2)	100 (30.5)	Note 3
	6 inch (150 mm)	7-1/2 (2.3)	40 (12.2)	100 (30.5)	Note 3
	8 inch (200 mm)	8-1/2 (2.6)	40 (12.2)	100 (30.5)	Note 3
	10 inch (250 mm)	9-1/2 (2.8)	40 (12.2)	100 (30.5)	Note 3
	12 inch (300 mm) and larger	10 (3.0)	40 (12.2)	100 (30.5)	Note 3
Tempered glass (Note 4)		8 (2.4)	--	--	Note 7
High silicon iron (Note 5)		15 (4.5)	--	--	Note 7

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
Polypropylene DWV		6 (1.8)	--	--	Note 7
PVDF DWV		6 (1.8)	--	--	Note 7
Cast iron soil pipe		10 (3.0)	--	--	Notes 7, 8
PVC, Schedule 40, for services at a maximum temperature of 100°F (38°C), and a maximum specific gravity of 1.0.					
	1/8 and 1/4 inch (3 and 6 mm)	Continuous Support	20 (6.1)	60 (18.3)	Note 3
	1/2 inch (13 mm)	3-1/2 (1.0)	20 (6.1)	60 (18.3)	Note 3
	3/4 and 1 inch (19 and 25 mm)	4 (1.2)	20 (6.1)	60 (18.3)	Note 3
	1-1/4 and 1-1/2 inch (31 and 38 mm)	4-1/2 (1.3)	20 (6.1)	60 (18.3)	Note 3
	2 inch (50 mm)	5 (1.5)	20 (6.1)	60 (18.3)	Note 3
	2-1/2 inch (63 mm)	5-1/2 (1.6)	20 (6.1)	60 (18.3)	Note 3

TABLE 2 - MAXIMUM PIPE SUPPORT SPACINGS AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe		Pipe Support Max Spacing	Max Run Without Expansion Joint, Loop, or Bend (Note 1)	Expansion Joint Max Spacing (Note 2)	Type of Expansion Joints
		feet (m)	Feet (m)	feet (m)	
	3 inch (75 mm)	6 (1.8)	20 (6.1)	60 (18.3)	Note 3
	4 inch (100 mm)	6-1/2 (1.9)	20 (6.1)	60 (18.3)	Note 3
	6 inch (150 mm)	7-1/2 (2.2)	20 (6.1)	60 (18.3)	Note 3
	8 inch (200 mm)	8 (2.4)	20 (6.1)	60 (18.3)	Note 3
	10 inch (250 mm)	8-1/2 (2.5)	20 (6.1)	60 (18.3)	Note 3
	12 inch (300 mm)	9-1/2 (2.9)	20 (6.1)	60 (18.3)	Note 3

Table 2 Notes:

1. Unless otherwise acceptable to Engineer, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.

2. Unless otherwise acceptable to Engineer, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.

3. Expansion joint fittings are specified in the respective piping procurement sections.

4. At least two properly padded supports for each pipe section.

5. At least one support for each pipe section.

6. Expansion joints shall be mechanical couplings.

7. No expansion joints are required.

8. Supports for 5 and 10 foot (1.5 and 3 m) long pipe sections shall be located within 18 inches (460 mm) of each joint. Supports shall be positioned to maintain the piping alignment and to prevent the piping from sagging.

3.3.01 Temperature Adjustments for PVC Pipe. PVC pipe at a temperature above 100°F (38°C) shall have maximum support spacings in accordance with the following table. For insulated lines, reduce the support spacing to 70 percent of the listed values.

TABLE 3 - MAXIMUM PIPE SUPPORT SPACINGS FOR PVC PIPE AT NON-STANDARD TEMPERATURES

feet (meters)

Nominal Size	Schedule 40		Schedule 80	
inches (mm)	120°F (49°C)	140°F (60°C)	120°F (49°C)	140°F (60°C)
1/4 (6)	Continuous Support		Continuous Support	
1/2 (13)	3 (0.9)	2-1/2 (0.7)	3-1/2 (1.0)	3 (0.9)
3/4 (19)	3-1/2 (1.0)	3 (0.9)	4 (1.2)	3 (0.9)
1 (25)	3-1/2 (1.0)	3 (0.9)	4-1/2 (1.3)	3-1/2 (1.0)
1-1/4 (31)	4 (1.2)	3-1/2 (1.0)	4-1/2 (1.3)	4 (1.2)
1-1/2 (38)	4 (1.2)	3-1/2 (1.0)	5 (1.5)	4 (1.2)

TABLE 3 - MAXIMUM PIPE SUPPORT SPACINGS FOR PVC PIPE AT NON-STANDARD TEMPERATURES feet (meters)				
Nominal Size	Schedule 40		Schedule 80	
inches (mm)	120°F (49°C)	140°F (60°C)	120°F (49°C)	140°F (60°C)
2 (50)	4-1/2 (1.3)	3-1/2 (1.0)	5 (1.5)	4-1/2 (1.3)
2-1/2 (63)	4-1/2 (1.3)	4 (1.2)	5-1/2 (1.6)	4-1/2 (1.3)
3 (75)	5 (1.5)	4 (1.2)	6 (1.8)	5 (1.5)
4 (100)	5-1/2 (1.6)	4-1/2 (1.3)	6-1/2 (1.9)	5-1/2 (1.6)
6 (150)	6-1/2 (1.9)	5 (1.5)	8 (2.4)	6-1/2 (1.9)
8 (200)	7 (2.1)	5-1/2 (1.6)	8-1.2 (2.5)	7 (2.1)
10 (250)	7-1/2 (2.2)	6 (1.8)	9 (2.7)	7-1/2 (2.2)
12 (300)	8 (2.4)	6-1/2 (1.9)	10 (3.0)	8-1/2 (2.5)

3.3.02 Temperature Adjustments for FRP Pipe. FRP pipe at a temperature above and below 150°F (66°C) shall have maximum support spacings in accordance with the following table.

TABLE 4 - MAXIMUM PIPE SUPPORT SPACINGS FOR FRP PIPE AT NON-STANDARD TEMPERATURES feet (meters)			
Nominal Size inches (mm)	Temperature		
	75°F (24°C)	175°F (79°C)	200°F (93°C)
1 (25)	5 (1.5)	3 (0.9)	2 (0.6)
1-1/2 (38)	6 (1.8)	3-1/2 (1.0)	2-1/2 (0.7)

TABLE 4 - MAXIMUM PIPE SUPPORT SPACINGS FOR FRP PIPE AT NON-STANDARD TEMPERATURES feet (meters)			
Nominal Size inches (mm)	Temperature		
	75°F (24°C)	175°F (79°C)	200°F (93°C)
2 (50)	7 (2.1)	4 (1.2)	3 (0.9)
3 (75)	7-1/2 (2.2)	4-1/2 (1.3)	3-1/2 (1.0)
4 (100)	8 (2.4)	5 (1.5)	4 (1.2)
6 (150)	10 (3.0)	6 (1.8)	4-1/2 (1.3)
8 (200)	11 (3.3)	6-1/2 (1.9)	5 (1.5)
10 (250)	12-1/2 (3.8)	7-1/2 (2.2)	5-1/2 (1.6)
12 (300)	13 (3.9)	8 (2.4)	6 (1.8)

3.3.03 Specific Gravity Adjustments for PVC and FRP Pipe. PVC and FRP pipe shall have the maximum spacing indicated in Tables 2, 3, and 4 adjusted in accordance with the following table when the specific gravity of the liquid is greater than 1.0. Table 5 shall not apply to PVC pipe containing alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution, as these services are specifically covered in Table 2.

TABLE 5 - MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND FRP PIPE	
Specific Gravity	Correction Factor
1.0	1.00
1.1	0.98
1.2	0.96

TABLE 5 - MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND FRP PIPE

Specific Gravity	Correction Factor
1.4	0.93
1.6	0.90
2.0	0.85
2.5	0.80
Air	1.40

3.4 INSTALLATION.

3.4.01 General. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas.

Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon total weight supported. Spacing of assemblies shall be determined by the minimum pipe size included in the group supported. Trapeze horizontal assemblies shall be structural angle or channel section of sufficient size to prevent measurable sag between rods. All lines shall be attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.

No copper pipe shall contact a pipe support or hanger of dissimilar metal. Hangers and supports for copper pipe shall be copper-plated, plastic coated, or copper pipe shall be galvanically isolated using Neoprene strips or other material as approved.

No piping shall be supported from the pipe above.

Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, or welded beam clips. Hanger support rods shall attach to concrete slabs or beams with inserts.

Anchorage shall be provided to resist both lateral and longitudinal seismic forces. Seismic forces shall be calculated assuming the pipes are full.

3.4.02 Inserts. Reference building structural concrete drawings for concrete inserts. When not provided as part of the building concrete structure, provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

Where concrete slabs form finished ceilings, provide inserts flush with the slab surface.

Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. X-ray locate existing reinforcing rods before drilling.

3.4.03 Pipe Hangers and Supports. Hanger rod sizing for copper pipe and plastic pipe shall be same as for steel pipe. Install hangers to provide a minimum 1/2 inch (13 mm) space between finished covering and adjacent work.

A hanger shall be placed with 18 inches (450 mm) of each horizontal elbow, and on both sides of all piping accessories and valves weighing 20 pounds (9 kg) or more.

Hangers shall have 1-1/2 inches (38 mm) minimum vertical adjustment.

Support horizontal cast iron and no-hub piping systems adjacent to each joint.

Support vertical piping at every floor using riser clamps.

Support riser piping independently or connected horizontal piping.

Hanger and hanger components shall be sized specifically for the pipe size it is to be used on.

3.5 PLACEMENT. Unless closer spacing is indicated on the drawings, the maximum spacing for pipe supports and expansion joints shall be as indicated in Tables 2, 3, 4, and 5.

Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

Unless otherwise indicated on the drawings or acceptable to Engineer, piping shall be supported approximately 1-1/2 inches (38 mm) out from the face of walls and at least 3 inches (75 mm) below ceilings.

End of Section

SECTION 15150

WATER METERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of water meters and associated appurtenances at the locations indicated on the drawings.

Pipe materials, valves, insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other Master Specification sections.

1.2 GENERAL.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts. and Tools shall apply to all equipment and materials furnished under this section.

1.2.02 Power Supply. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.03 Number Plates. Each water meter which has been assigned a number on the drawings shall be provided with a number plate mounted on or adjacent to the device in a manner acceptable to the Engineer. Nameplates shall have black baked enamel letters at least 3/4 inch (19 mm) high on anodized aluminum plate. .

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication, assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Performance curves indicating flow capacity versus pressure drop.

Accuracy.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Power requirements.

Net weight.

Wiring diagrams.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance withMaster Specification Section 01160, Training, and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Construction. Water meters shall be constructed in accordance with the following standards:

Displacement Water Meters	AWWA C700
Turbine Water Meters	AWWA C701
Compound Water Meters	AWWA C702
Propeller Water Meters	AWWA C704

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts. and Tools .

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Water meters shall be designed and selected to meet the specified conditions as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Water meters shall be designed to meet the performance and design conditions indicated in the Contract Documents, and on the water meter schedule.

Each meter shall measure the actual flow within the accuracy specified over the indicated flow range with a water temperature range of 32°F (0°C) to 120°F (50°C). The accuracy shall be expressed as a percentage of the actual flow and not as a percent of maximum flow.

Meter assemblies shall have performance capabilities of continuous operation up to the rated maximum flows without affecting long-term accuracy or causing any undue component wear. All meter assemblies shall also have a 25 percent flow capacity in excess of the maximum flows as indicated in the Contract Documents for intermittent flow demands.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 DESIGN AND CONSTRUCTION.

2.4.01 Displacement Meters. Displacement meters shall be nutating or oscillating disc type with bronze or synthetic polymer housing as indicated in the schedules, thermoplastic plastic chamber and hard rubber disc. Accuracy shall be ±1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Each meter shall be provided with threaded union type spud end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Displacement type meters shall be Badger Meter Inc., "Recordall Disc Meter", ABB Water Meters, Inc, or approved equal.

2.4.02. Turbine Meters. Turbine meters shall be moving rotor type with bronze, cast iron, or 316 stainless steel housing as indicated in the schedules, thermoplastic rotor, ceramic bearings, stainless steel straightening vanes, Buna N "O" ring, and Nitrile head gasket. Accuracy shall be ±1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Meters in 2 inch and smaller sizes shall be provided with threaded union type spud end connections. Meters in larger than 2 inch sizes shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Turbine type meters shall be Badger Meter Inc., "Recordall Turbo Meter", ABB Water Meters, Inc, or approved equal.

2.4.03 Compound Meters. Compound meters shall incorporate a positive displacement chamber for measuring low flows, a turbine chamber for measuring high flows, and a valve for diverting flow to the respective chamber. Compound meters shall be provided with a single housing or may be provided with independent housings factory piped with a single inlet and outlet connection. Meters shall be provided with bronze housings and piping, thermoplastic rotor, valve casing, and disc chamber, and stainless steel straightening vanes. Accuracy shall be ±1.5 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Meters shall be provided with ANSI Class 125 flanged end connections.

Meter registers shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Compound type meters shall be Badger Meter Inc., "Recordall Compound Meter", ABB Water Meters, Inc, or approved equal.

2.4.04 Propeller Meters. Propeller meters shall be rotating propeller type with cast iron housing, copper stabilized polypropylene propeller, graphite/stainless steel propeller bearing, graphite/carbide thrust bearing, and stainless steel straightening vanes. Accuracy shall be ±2 percent over the full meter range. The meter shall be suitable for an operating temperature range of 32°F (0°C) to 120°F (50°C) and a working pressure of 150 psi (1,050 kPa). Meters shall be provided with ANSI Class 125 flanged end connections.

Meter register shall totalize flow through the meter, and shall be equipped with a direct numerical readout and a center-sweep test hand. Meter register and lid shall be constructed of synthetic polymer. Propeller type meters shall be Badger Meter Inc., "Series MFLT Propeller Meter", Sparling Instruments, Inc, or approved equal.

2.5 PAINTING AND COATINGS.

2.5.01 Surface Preparation. All iron and steel surfaces shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint or coating manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.5.02 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Coatings located in water passages shall comply with AWWA requirements for use with potable water and shall be NSF certified. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Master Specification Section 09900, Painting.

2.6 ELECTRICAL. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 INSTALLATION. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Meters shall be installed with the required upstream and downstream straight pipe lengths as recommended by the manufacturer.

3.3 FIELD QUALITY CONTROL.

3.3.01 Installation Check. Unless indicated otherwise, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.4 ADJUSTING. Meters shall be calibrated and adjusted according to manufacturer’s written instructions after installation. Meter faces shall be adjusted to proper angle for best visibility.

3.5 PROTECTION. Meters and appurtenances shall be protected from damage immediately after installation. Scratched, cracked or broken components shall be replaced. Meters shall not be used during the construction.

3.6 CLEANING. After completion of testing and immediately before the final inspection, meters shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer.

End of Section

SECTION 15180

VALVE AND GATE ACTUATORS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of manual and powered valve and gate actuators and accessories.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Valve and gate actuators shall be furnished with all necessary parts and accessories indicated on the drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.

1.2.01 General Equipment Requirements. The General Equipment Stipulations Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to the equipment and materials furnished under this section.

1.2.02 Governing Standards. Except as modified or supplemented herein, all powered actuators shall conform to applicable requirements of ANSI/AWWA C540.

Except as modified or supplemented herein for butterfly and eccentric plug valves, all manual and cylinder actuators shall conform to the applicable requirements of ANSI/AWWA C504.

Except as modified or supplemented herein for ball valves, all manual actuators shall conform to the applicable requirements of ANSI/AWWA C507.

Except as modified or supplemented herein, all sluice and slide gate, manual actuators shall conform to the applicable requirements of AWWA C501.

1.2.03 Power Supply. Power supply to electric actuators will be as indicated on the valve or gate schedule.

1.2.04 Marking. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.

1.2.05 Temporary Number Plates. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve or gate by number or service as indicated in the valve or gate schedule.

1.3 SUBMITTALS. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.

When requested by Engineer, certified copies of physical and chemical test results shall be submitted for the materials of construction for the actuator components.

The drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.

Certified copies of reports covering proof-of-design testing of each electrically operated or controlled actuator, as set forth in Section 6 of ANSI/AWWA C540 together with an affidavit of compliance, as indicated in Section 1.7 of ANSI/AWWA C540 shall be submitted to Engineer before the actuators are shipped.

1.4 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

2.1.01 General. Valve and gate actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective Master Specification valve and gate sections.

Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

2.1.02 Valve Actuators. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve and gate section schedules.

Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and handwheel or chainwheel positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the drawings or directed by Engineer.

2.1.03 Gate Actuators. Actuators, regardless of type, shall be sized to produce the torque or thrust required to operate the applicable gate when the gate is subject to the seating and unseating operating heads as indicated in the respective gate section schedules.

Both the design head and the operating head shall be measured from the surface of the liquid to the center line of the gate.

2.1.04 Limit Switches. When manual or cylinder operated valves or gates require limit switches for instrumentation or controls, the limit switches shall be provided as required in their respective valve and gate schedules.

Each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts dc. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".

2.1.05 Sealing. When valves are to be buried, submerged, or installed in vaults, the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective schedules but not less than 20 feet (6.1 m).

2.2 MATERIALS. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of ANSI/AWWA C504 and C540.

2.3 VALVE MANUAL ACTUATORS.

2.3.01 General. Manual actuators of the types listed in the Valve Schedules shall be provided by the valve manufacturer.

All valves, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

Unless otherwise required by Owner, the direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open. The direction of rotation of the wheel or wrench nut to open gate valves shall be to the right (clockwise).

The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

Each valve actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator. Other lever actuators shall be designed so that the valve can be readily locked open, closed, or in at least five intermediate positions.

Geared actuators for plug valves not listed in the Eccentric Plug Valve Schedule shall be rated for a differential pressure across the valve, on the seating side of 100 psi (680 kPa) for 8 inch (200 mm) and smaller valves, 50 psi (340 kPa) for 10 inch (250 mm) and larger valves, and 25 psi (170 kPa) for gas service valves.

Manual actuators shall produce the required torque with a maximum pull of 80 pounds (356 N) on the lever or handwheel. Actuator components shall withstand, without damage, a pull of 200 pounds (890 N) on the handwheel or chainwheel or an input of 300 foot-pounds (407 J) on the operating nut.

2.3.02 Handwheels. Handwheel diameters shall be at least 8 inches (150 mm) but not more than 24 inches (600 mm) for 30 inch (750 mm) and smaller valves and not more than 30 inches (750 mm) for 36 inch (900 mm) and larger valves.

2.3.03 Chainwheels. Unless specifically required to be equipped with other types of actuators in the respective valve schedules, all valves with center lines more than 7'-6" (2.3 m) above the floor shall be provided with chainwheels and operating chains. Each chainwheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet (1.2 m) of the floor below the valve.

2.3.04 Lever Actuators. Lever actuators shall be designed to produce the specified torque with a maximum pull of 80 pounds (350 N). Levers on valves for throttling service shall have an infinitely variable locking device, and levers for other valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.

2.3.05 Chain Levers. Chain lever actuators shall be designed to produce the specified torque with a maximum pull of 80 pounds (350 N) on the chain. Suitable actuator extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be hot-dip galvanized carbon steel and shall be looped to extend to within 4 feet (1200 mm) of the floor below the valve.

2.3.06 Wrench Nuts. Wrench nuts shall be provided on all buried valves, on all valves that are to be operated through floor boxes, and where indicated on the drawings. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 3.16 of AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

2.3.07 Operating Stands. Operating stands shall be provided in the locations indicated on the drawings. Operating stands shall support the handwheel approximately 36 inches (900 mm) above the floor. A sleeve made from standard weight galvanized steel pipe shall be provided for the opening in the floor beneath each operating stand. When stems are 10 feet (3 m) or longer, a suitable thrust bearing shall be provided in each operating stand to carry the weight of the extension stem. Operating stands in exterior locations shall be cast iron. Operating stands in interior locations shall be cast iron or fabricated steel as indicated in the Contract Documents.

2.3.08 Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the drawings or indicated in the respective gate schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2.4 GATE MANUAL ACTUATORS.

2.4.01 General. Manual actuators of the types as required for each gate in the Gate Schedules shall be provided by the gate manufacturer.

All bearings and gears shall be totally enclosed in a weathertight housing having a sufficient number of fittings to permit periodic lubrication of all internal moving components without partial or total disassembly of the mechanism. The pinion shaft of crank-operated mechanisms shall be supported by roller bearings or needle bearings.

All manual actuators shall conform to the requirements of Section 3.14 of AWWA C501, or each manual actuator shall be designed to operate the gate when a 40 pound (178 N) effort is applied to the crank or the handwheel and shall be able to withstand, without damage, an effort of 200 pounds (890 N), as required.

When specified, manual actuators for rising stem self-contained gates shall be designed for mounting directly on the frame yoke.

When a portable electric actuator will be furnished, all crank-operated geared manual actuators shall be suitable for operation with the portable electric actuator specified herein. A suitable adapter coupling shall be furnished with each manual actuator when required to couple the portable actuator to the actuator pinion shaft.

2.4.02 Floorstands. Floorstands shall be designed to transfer operating thrusts to the supporting structure. Each floorstand shall be designed to position the crank or the handwheel approximately 36 inches (900 mm) above the frame yoke, supporting surface, or adjacent operating floor or platform.

2.4.03 Wall Brackets. Wall brackets shall be provided to support manual actuators in the locations indicated on the drawings or indicated in the respective gate schedules. The horizontal face of the bracket shall be predrilled to accept the actuator and the stem without modification. The top of the bracket shall extend sufficiently to bear on and transfer thrust loads to the top of the supporting structure.

2.4.04 Dual Actuators. Dual actuators shall be provided for the gates so indicated in the respective gate schedules. Dual actuators shall be interconnected by a cross shaft complete with required couplings so both stems move at the same rate. Each cross shaft shall be protected by a full length removable aluminum or stainless steel cover attached to the yoke beam or actuator.

2.4.05 Remote Actuators. Gates as indicated in the respective gate schedules, to be provided with a remote actuator, shall be operated by a frame-mounted handwheel and chain drive. An extension shaft suitable for connection to the pinion shaft of the benchstand shall be provided complete with a roller chain, shaft couplings, support bearings, and a roller chain sprocket keyed or bolted to the end of the shaft. A handwheel with bearing housing and sprocket shall be bolted to the side frame approximately 48 inches (1200 mm) above the operating floor. Removable aluminum or stainless steel weathertight covers shall be provided to protect the extension shaft, drive chain, and sprockets. Handwheel and sprocket diameters shall be selected to operate the gate under the maximum specified seating pressure with an effort of not more than 40 pounds (178 N) applied to the rim of the handwheel. Handwheels and sprockets shall be able to withstand a 100 pound (445 N) effort without damage.

2.4.06 Stem Covers. Unless otherwise specified, each rising stem manual actuator shall be provided with a stem cover. Stem covers shall conform to Section 3.4 of AWWA C501.

2.4.06.01 Plastic Covers. When specified in the respective gate schedule, stem covers shall be constructed of transparent plastic pipe and shall be furnished with an end cap, condensation vents, and a clear mylar position-indicating marking tape. The marking tape shall be adhesive backed and shall be permanently marked and calibrated in feet and inches [meters and millimeters]. The tape shall be applied to the stem cover after the gate has been installed and shall be so positioned that the height of the slide will be indicated by reference to the top of the stem.

2.4.06.02 Steel Covers. When specified in the respective gate schedule, stem covers shall be constructed from steel pipe and shall be furnished complete with a threaded end cap. All steel components of each cover shall be hot-dip galvanized following fabrication.

2.4.06.03 Slide Position Indicators. Each sluice gate operating mechanism with a steel stem cover shall be furnished with a digital or dial type mechanical position indicator. The indicator mechanism shall be installed inside a weatherproof housing and shall be clearly visible through a transparent, weatherproof window.

2.5 ELECTRIC ACTUATORS.

2.5.01 General. Electric actuators as listed in the Valve and Gate Schedules shall be provided by the valve or gate manufacturer.

Electric actuators for 12 inch (300 mm) and smaller butterfly valves and eccentric plug valves shall be quarter-turn type and shall be Auma "SG05.1" through "SG12.1", EIM Series HQ, Limitorque "QX", or Rotork "IQT", without exception.

All other electric actuators shall be multiturn type and shall be Auma "SA07.2" through "SA48.1", EIM "Series M2CP", Limitorque "L120" with "B320" bevel gearbox operator, or Rotork "IQ3" with "Type MTW" or "Type IWS" worm gear operator, without exception.

Electric actuators produced by other manufacturers are not acceptable.
Each electric actuator shall be furnished complete with a motor, gearing, handwheel, limit switches and torque sensors, lubricants, heating elements, wiring, and terminals. Each actuator shall be constructed as a self-contained unit with a cast

iron, weatherproof, submersible, or explosionproof housing, as specified herein, and shall be integrally assembled on the applicable valve or gate by the valve or gate manufacturer. Housings for quarter-turn actuators may be cast iron or die-cast aluminum alloy.

Actuators for valves and gates shall be designed to cycle the valve or gate from the fully open to the fully closed position or the reverse in approximately 60 seconds or as required.

Actuator motors may be mounted horizontally adjacent or vertically above the reduction gearing. All gearing shall be either oil bath or grease lubricated. When grease lubrication is used, in no case shall motors be mounted vertically below the gearing.

2.5.02 Motors. Motors shall be totally enclosed, high torque design made expressly for valve actuator service, capable of operating the valve under full differential pressure for a complete open-close and reverse cycle of travel at least twice in immediate succession without overheating. Motors shall be designed in accordance with NEMA standards and shall operate successfully at any voltage within 10 percent above or below rated voltage. Motor bearings shall be permanently lubricated.

2.5.03 Power Gearing. Power gearing shall consist of hardened steel spur or helical gears and alloy bronze or hardened steel worm gear, all suitably lubricated, designed for 100 percent overload, and effectively sealed against entrance of foreign matter. Steel gears shall be hardened to at least 350 Brinell. Planetary or cycloidal gearing or aluminum, mild steel, or nonmetallic gears will not be acceptable. Gearing shall be designed to be self-locking so that actuation of a torque switch by a torque overload condition will not allow the actuator to restart until the torque overload has been eliminated. If a secondary gear box is required, it shall be designed to withstand the locked rotor torque of the actuator.

2.5.04 Handwheel Mechanism. The handwheel shall not rotate during motor operation. During handwheel operation the motor shall not affect the actuator operation. The actuator shall be responsive to electrical power and control at all times and, when under electrical control, shall instantly disengage the handwheel. Unless otherwise required by Owner, the handwheel shall rotate counterclockwise to open the valve. An arrow indicating the opening direction and the word "Open" shall be cast on the handwheel. The force required to operate the handwheel shall not exceed 80 pounds (350 N).

2.5.05 Torque Sensing. Torque and thrust loads in both closing and opening directions shall be limited by a torque sensing device. Each torque sensing device shall be provided with an adjustment setting indicator. The adjustment shall permit a variation of approximately 40 percent in torque setting. Switches shall have a rating of not less than 6 amperes at 120 volts ac and 0.5 ampere at 115 volts dc.

2.5.06 Limit Switches. Each electric actuator shall be designed to be readily field adaptable for four limit switch assemblies. Each switch assembly shall consist of at least three separate limit switches, shall be operated by the driving mechanism, and shall be independently adjustable to trip at any point at and between the fully open and fully closed valve positions. All switches shall have an inductive contact rating of not less than 6 amperes at 120 volts ac, 3 amperes at 240 volts ac, 1.5 amperes at 480 volts ac, and 0.5 ampere at 115 volts dc.

Each quarter-turn actuator shall be provided with end-of-travel limit switches in addition to four spdt switches, each independently adjustable at any point of valve travel.

2.5.07 Position Transmitter. When specified, valves shall be provided with an electronic type position transmitter. The transmitter output shall be an isolated 4-20 mA dc capable of driving an external load of 0 to 500 ohms. Accuracy of the transmitted signal shall be plus or minus 2.0 percent of span. Repeatability and hysteresis shall be within 1.0 percent. The transmitter shall transmit to a remote position indicator which is specified in the instrumentation section.

2.5.08 Heating Elements. Space heating elements shall be provided to prevent condensation in the motor and limit switch housing. Heating elements shall be rated 120 volts ac. Heaters shall be continuously energized.

2.5.09 Terminal Facilities. Terminal facilities for connection to motor leads, switches, position transmitter, and heating elements shall be provided in readily accessible terminal compartments. Each terminal compartment shall have at least two openings for external electrical conduits, one sized at least 3/4 inch (19 mm) and the other at least 1-1/4 inches (31 mm). Each terminal compartment shall be large enough to allow easy routing and termination of fifteen 12 AWG (4 mm^2) conductors.

2.5.10 Controller. Each valve shall be furnished with a reversing controller located either inside the actuator housing or mounted on the housing in a NEMA Type 4 or stainless steel enclosure as required. The controller shall be equipped with:

A motor overload protective device in each phase or solid state motor protection.

A space heater element, rated 120 volts ac, sized to be continuously energized for prevention of condensation within the controller enclosure.

A fused control power circuit taken from one power lead on the load side of the breaker and line side of the reversing starter to ground. If power supply is greater than 120 volts ac, a control power transformer with fused secondary, with volt-ampere capacity suitable for starter control plus continuous service to space heater elements in motor housing, limit switch compartment, and controller enclosure.

A terminal block with connectors for all external controls. All leads from the actuator motor and limit switch assembly shall be routed to terminal connections in the controller for external connections to all other control devices.

Reversing controllers shall be both mechanically and electrically interlocked and provided with the necessary direct-operated auxiliary contacts for required interlocking and control.

Valve controllers shall be expressly selected for long life and reliable, low maintenance service under rugged service conditions.

2.5.11 Control Module. Valves listed for modulating service in the Butterfly Valve Schedule shall be provided with a control module for position modulating type service. The control module shall be mounted within the valve actuator limit switch housing. The module shall accept a standard 4-20 mA dc analog input signal with a load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband.

The actuator shall have a slide-wire type position feedback potentiometer which provides a position feedback signal to the control module.

A "Manual-Automatic" selector switch shall be provided. When specified herein, the actuators shall have "Open-Close" momentary contact push buttons for local electric operation in the manual mode.

2.5.11.01 Control Performance. For any operating torque within the specified range of the valve actuator, the valve and actuator shall perform within these specified limits:

Linearity	Linearity of actual valve position as compared to demand signal shall be within plus or minus 4.0 percent of span over the entire operating range.
Repeatability	For any repeated demand signal to the valve

	actuator, the actual valve position shall be repeated
Deadband	Deadband of the valve actuator shall be adjustable from 1.0 to 10 percent of span.
Hysteresis	For any repeated demand signal to the valve actuator, from either an increasing or a decreasing direction, the actual valve position shall be repeated within 1 degree of valve shaft rotation.

2.6 HYDRAULIC CYLINDER ACTUATORS.

2.6.01 General. Hydraulic cylinder actuators as listed in the Valve or Gate Schedules shall be provided by the valve or gate manufacturer.

2.6.02 Hydraulic Cylinder Actuators. Hydraulic cylinder actuators of the double acting type shall be provided by the valve manufacturer. Cylinders shall be of tie-rod or bolted-flange construction; shall be sized to provide the safety factors stipulated in Table 6 in Section 3.8 of ANSI/AWWA C504; and shall be designed to provide satisfactory operation with either water or oil as required. Operating pressure range shall be as required. Cylinders shall be shop tested at 300 psig [2070 kPa gauge]. Actuators with nonmetallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view.

2.6.03 Control Devices. When specified in the respective valve schedule, a 4-way solenoid valve, with manual actuator when specified herein, shall be provided to control the operation of each hydraulic cylinder operated valve. Each solenoid valve shall be heavy-duty, single solenoid, two-position type rated for a differential operating hydraulic pressure of 125 psig (860 kPa gauge). Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch (12.7 mm) threaded conduit connection. Solenoid valves shall be rated for use with a power supply, as specified herein, and shall be ASCO "Model No. 8344G70MO 4-Way Pilot Operated Solenoid Valves" with manual override features as manufactured by Automatic Switch Co.

Each hydraulic connection on each cylinder shall be equipped with an adjustable flow control valve. The flow control valves and connecting piping shall be arranged to permit control of the flow rate of exhaust fluid from the cylinder and to permit the independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the cylinder piston to complete its stroke can be adjusted from 30 to 120 seconds with fluid supply pressure as specified herein. Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol".

An oil reservoir shall be provided in the oil piping connecting the two flow control valves on each oil hydraulic cylinder.

2.7 AIR CYLINDER ACTUATORS.

2.7.01 General. Air cylinder actuators as listed in the Valve or Gate Schedules shall be provided by the valve or gate manufacturer.

2.7.02 Air Cylinder Actuators. Air cylinder actuators of the double acting type shall be provided by the valve manufacturer. Cylinders shall be sized to provide the safety factors stipulated in Table 6 in Section 3.8 of ANSI/AWWA C504, except as specified herein, and shall be designed to provide satisfactory operation using air, or when specified herein, dry, oil-free instrument air at 80 psig (550 kPa gauge) pressure and shall be shop tested at 240 psig (1650 kPa gauge).

Actuators with nonmetallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view.

2.7.03 Control Devices. When specified in the respective valve schedule, a 4-way solenoid valve with manual actuator, when required, shall be provided to control the operation of each air cylinder operated valve. Each solenoid valve shall be heavy-duty, single solenoid, two-position type rated for a differential operating air pressure of 125 psig (860 kPa gauge). Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch (12.7 mm) threaded conduit connection. Solenoid valves shall be rated for use with a power supply, as required, and shall be ASCO "Model No. 8344G70MO 4-Way Pilot Operated Solenoid Valves" with manual override features as manufactured by Automatic Switch Co.

Each air connection on each cylinder shall be equipped with an adjustable flow control valve. The flow control valves and connecting piping shall be arranged to permit control of the flow rate of exhaust air from the cylinder and to permit independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the air cylinder piston to complete its stroke is adjustable between 20 and 60 seconds, with an air supply pressure of 80 psig (550 kPa gauge). Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol".

2.7.04 Single Acting-Spring Return Air Cylinder Actuators. When specified in the respective valve schedules, air cylinder actuators of the single acting-spring return type shall be provided by the valve manufacturer. Cylinders shall provide satisfactory operation for air of the specified quality and shall be shop tested at 240 psig (1650 kPa gauge). Actuators with non-metallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

The valve actuator mechanism coupled to the cylinder shall be totally enclosed. The cylinder shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rod shall be enclosed in the mechanism housing and shall not be exposed to view. The actuator shall be configured such that on power failure, the spring shall drive the valve open or closed. Each actuator shall be furnished with a 3-way solenoid valve. A flow control valve shall be furnished and installed in the solenoid valve vent.

2.8 AIR-OIL CYLINDER ACTUATORS.

2.8.01 General. Air-oil cylinder actuators as listed in the Valve or Gate Schedules shall be provided by the valve or gate manufacturer.

2.8.02 Air-Oil Cylinder Actuators. Air-oil cylinder actuators may be of the double acting or opposed cylinder type.

For eccentric plug valves, cylinders shall be of tie-rod or bolted-flange construction and shall be sized to provide the safety factors stipulated in Table 6 in Section 3.8 of ANSI/AWWA C504.

Each cylinder unit shall consist of an air cylinder driving an oil hydraulic cylinder of the same diameter, mounted together as a single assembly. Cylinders shall be of the tie-rod or bolted-flange construction. The air cylinder shall operate the valve, and the oil cylinder shall regulate the opening and closing speeds. Each unit shall be provided with an oil reservoir and two flow control valves on the oil cylinder.

The valve actuator mechanism coupled to the cylinders shall be totally enclosed. The cylinders shall be rigidly secured to the mechanism housing and shall not pivot, rotate, or swing during operation. The cylinder piston rods shall be enclosed in the mechanism housing and shall not be exposed to view.

The air cylinder shall be designed to provide satisfactory operation using air, or when specified herein, dry, oil-free instrument air at 80 psig (550 kPa gauge) pressure. The oil cylinder shall be designed to operate at an internal pressure not to exceed 80 psig (550 kPa gauge).

For AWWA butterfly valves; actuators with nonmetallic cylinders, as manufactured by Chicago Fluid Power, DeZurik, or Pratt, will be acceptable.

2.8.03 Control Devices. When specified in the respective valve schedule, a 4-way solenoid valve shall be provided to control the operation of each air-oil cylinder operated valve. Each solenoid valve shall be heavy-duty, single solenoid, two-position type rated for a differential operating air pressure of 125 psig (860 kPa gauge). Each valve shall be designed and constructed for exceptionally long life, with forged brass body; poppet type seats and discs; continuous duty, molded, Class F coil; NEMA Type 4 solenoid enclosure; and 1/2 inch (12.7 mm) threaded conduit connection. Solenoid valves shall be ASCO "Model No. 8344G70MO 4-Way Pilot Operated Solenoid Valves" with manual override features as manufactured by Automatic Switch Co.

Each oil connection on the oil cylinder shall be equipped with an adjustable flow control valve. The flow control valves and connecting oil piping shall be arranged to permit control of the flow rate of exhaust oil from the cylinder and to permit independent adjustment and control of valve opening and closing speeds. Control valves shall be sized so that the time required for the air cylinder piston to complete its stroke is adjustable between 30 and 300 seconds. Flow control valves shall be manufactured from brass or stainless steel and shall be Parker Hannifin "Colorflow F Series" or Mead "Dyla-Trol". An oil reservoir shall be provided in the oil piping connecting the two flow control valves.

2.9 PORTABLE ELECTRIC ACTUATOR. Contractor shall furnish the number of portable, electric motor driven actuators, as specified herein, with adjustable fabricated steel tripod suitable for operation of all crank-operated gates specified in Master Specification Section 02546, Sluice Gates. When indicated in the Contract Documents the portable electric actuators shall be suitable for operating all existing manual sluice and slide gate actuators.

When indicated in the Contract Documents, the actuator shall be reversible and shall be equipped with an overload release clutch for protection of the operated equipment. The clutch shall be adjustable, spring-loaded, drive-pawl type which releases instantly at a preset, predetermined torque. Disc friction clutches or shear pins will not be acceptable.

The actuator shall be suitable for operation with 120 volt, 60 Hz, single phase power, or as specified herein. A three-conductor, heavy-duty, neoprene jacketed, portable cord, with 12 AWG (4 mm^2) copper conductors and a standard grounding type plug, of a length as specified herein, shall be provided with the actuator.

Coordination of the portable actuator with the all new and existing manual actuators shall be the responsibility of Contractor.

2.10 PORTABLE HYDRAULIC ACTUATOR. Contractor shall furnish the number of portable, hydraulic driven actuators, as indicated in the Contract Documents, suitable for operation of all crank-operated sluice gates specified in Master Specification Section02546, Sluice Gates. When indicated in the Contract Documents the portable hydraulic actuators shall be suitable for operating all existing manual sluice gate actuators.

When indicated in the Contract Documents, the actuator shall be reversible and shall be equipped with an overload release clutch for protection of the operated equipment. The clutch shall be adjustable, spring-loaded, drive-pawl type which releases instantly at a preset, predetermined torque. Disc friction clutches or shear pins will not be acceptable.

The portable hydraulic actuator shall be mounted on a lightweight structural steel frame with two wheels for ease of movement. The unit shall consist of a four-cycle gasoline engine with a recoil starter driving a hydraulic pump. The unit shall include all necessary hoses, a hydraulic motor, oil reservoir and four way valve.

2.11 ACTUATOR ACCESSORIES.

2.11.01 EXTENSION STEMS. Extension stems and stem guides shall be furnished when indicated on the respective valve schedule, indicated on the drawings, or otherwise required for proper valve or gate operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the valve actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.

At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet (3 m), whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

Extension stems for buried valves actuators shall extend to within 6 inches (150 mm) of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.

When indicated in the Contract Documents, extension stems for buried valve actuators shall be provided with position indicators.

2.11.02 POSITION INDICATORS. Unless otherwise specified, each valve actuator shall be provided with a position indicator to display the position of the plug or disc relative to the body seat opening.

For quarter turn plug, ball, or cone type valves installed in interior locations, the indicating pointer shall be mounted on the outer end of the valve operating shaft extension and shall operate over an indicating scale on the operating mechanism cover. Where the shaft passes through the cover, a suitable stuffing box or other seal shall be provided to prevent the entrance of water.

Each actuator for butterfly valves, except actuators that are located in manholes, buried, or submerged, shall have a valve disc position indicator mounted on the end of the valve shaft. A disc position indicator shall also be provided on each operating stand or the actuator mounted thereon.

2.11.02.01 Position Indicators for Buried Actuators. When specified in the respective valve schedule, each buried valve actuator shall be equipped with a position indicator. Position indicators shall be Indico "Model 179 Valve Position Indicators" manufactured by the Mills Engineering Company, Needham Heights, Massachusetts, or "Diviner" ground level position indicator manufactured by the Henry Pratt Company, Aurora, Illinois. Each indicator assembly shall be designed for installation on the extension stem connected to the operating stem of the buried actuator mechanism and shall be mounted in the top section of the valve box beneath the valve box cover. Each indicator shall be equipped with a wrench nut. Internal gearing shall be sealed and protected from the elements.

2.11.03 FLOOR BOXES. Openings through concrete slabs provided for key operation of valves shall be provided with a cast iron floor box complete with cover. The floor box shall be of the depth indicated on the drawings. Where the operating nut is in the slab, the stem shall have a guide to maintain the nut in the center of the box; where the nut is below the slab, the opening in the bottom of the box shall accommodate the operating key.

Each floor box and cover shall be shop coated with manufacturer’s standard coating.

2.11.04 TORQUE TUBES. Torque tube shall utilize pipe rather than solid shafting between the valve input shaft and the output shaft of the valve floorstand operator. An adjustment of 2 inches shall be provided in the torque tub installation. Torque tube shall be coated with the same material as the submerged valve.

2.12 SHOP COATING. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting in Master Specification Section 09900, Painting.

The following surfaces shall be painted:

Polished or Machined Surfaces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION. Actuators will be installed on the valves in accordance with Master Specification Section 15010, Valve Installation and Master Specification Section 02546, Sluice Gates.

End of Section

SECTION 15190

NATURAL GAS PIPING

PART 1 - GENERAL

1.1 SCOPE. This Section includes fuel gas piping within the building. Products include the following:

Pipe, tube, fittings, and joining materials.

Protective pipe and fitting coating.

Piping specialties

1.2 PROJECT CONDITIONS.

Gas System Pressure: One pressure range. More than 0.5 psig (3.45 kPa) but not more than 5.0 psig (34.5 kPa).

1.3 SUBMITTALS

1.3.01 Product Data. Submit product data for each type of product indicated.

1.3.02 Shop Drawings. Submit shop drawings for fuel gas piping. Include plans and attachments to other work. Show different pressure zones and indicate pressure for each zone.

1.3.03 Field Quality-Control Test Reports. Submit field quality control test report results.

1.3.04 Operation And Maintenance Data. Submit operation and maintenance data for each type of product indicated.

1.4 QUALITY ASSURANCE.

Electrical Components, Devices, and Accessories. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

NFPA Standard. Comply with NFPA 54, "National Fuel Gas Code."

1.5 WARRANTY. In the event that the equipment or components fail to perform satisfactorily at any time within the Defects Liability period the Contractor shall replace it with one capable of operating as specified and shall comply with the requirements in Division 1.

The Contractor shall be responsible for all cost incurred in furnishing and installing the replacement equipment.

1.6 SPARE PARTS. Spare parts shall meet the requirements of Sections 01750 and 01760.

PART 2 - PRODUCTS

2.1 MANUFACTURERS. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

Corrugated, Stainless-Steel Tubing Systems. Comply with AGA LC 1 and include the following:

Tubing: Corrugated stainless steel with plastic jacket or coating.

Fittings: Copper alloy with ends made to fit corrugated tubing. Include ends with threads according to ASME B1.20.1 if connection to threaded pipe or fittings is required.

Striker Plates: Steel, designed to protect tubing from penetrations.

Steel Pipe. ASTM A 53/A 53M; Type E or S; Grade B; Schedule 80; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.

Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.

Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.

Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1 or butt-welded joints.

Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.

Joint Compound and Tape: Suitable for natural gas.

Soft Copper Tube. ASTM B 88, Type L (ASTM B 88M, Type B), annealed temper.

Copper Fittings: ASME B16.22, wrought copper, streamlined pattern.

Brazing Filler Metals: AWS A5.8, Silver Classification BAg-1. Filler metal containing phosphorus is prohibited.

2.3 PROTECTIVE COATING. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in contact with materials that may corrode the pipe.

2.4 PIPING SPECIALTIES.

Flexible Connectors. ANSI Z21.24, copper alloy.

Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

PART 3 - EXECUTION

3.1 PREPARATION. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.2 PIPING APPLICATIONS. Use flanges, unions, transition, and special fittings in applications below, unless otherwise indicated.

Fuel Gas Piping, 5 psig (34.5 kPa) or less:

NPS 1/2 (DN 15) and Smaller: NPS 3/4 (DN 20) steel pipe, malleable-iron threaded fittings, and threaded joints, Soft copper tube, copper fittings, and brazed joints and Corrugated, stainless-steel tubing system and threaded joints.

NPS 3/4 and NPS 1 (DN 20 and DN 25): Steel pipe, malleable-iron threaded fittings, and threaded joints, Soft copper tube, copper fittings, and brazed joints, Corrugated, stainless-steel tubing system and threaded joints.

NPS 1-1/4 to NPS 3 (DN 32 to DN 70): Steel pipe, malleable-iron threaded fittings, and threaded joints.

NPS 4 and larger. (DN 100) Steel, malleable-iron threaded fittings and butt-welded joints.

3.3 VALVE APPLICATIONS.

Appliance Shutoff Valves for Pressure 0.5 psig (3.45 kPa) or Less: Appliance connector valve or gas stop.

Appliance Shutoff Valves for Pressure 0.5 to 2 psig (3.45 to 13.8 kPa): Gas stop or gas valve.

Piping Line Valves, NPS 2 (DN 50) and Smaller: Gas valve.

Valves at Service Meter, NPS 2 (DN 50) and Smaller: Gas valve.

3.4 INSTALLATION. Basic piping installation requirements and piping joint construction are specified in Division 15 Section 15051 "Piping- General Requirements."

Install pressure gage, upstream and downstream from each service pressure regulator. Pressure gages are specified in Division 15 Section "Piping Specialties."

Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

Above-Ceiling Locations: Gas piping without conduit may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.

In Walls: Gas piping with welded joints and protective wrapping specified in Part 2 "Protective Coating" Article may be installed in masonry walls, subject to approval of authorities having jurisdiction.

Underground Locations: Locate buried pipe a maximum depth as required by code to prevent damage. Low points and drip trap legs to be located inside of building.

Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

<u>Drips and Sediment Traps</u>: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.

> Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches (75 mm) long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings unless specifically shown to be exposed to view.

Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Connect branch piping from top or side of horizontal piping.

Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.

Install pressure gage, upstream and downstream from each line pressure regulator. Pressure gages are specified in Division 15 Section 15120 "Piping Specialties."

Install flanges on valves, specialties, and equipment having NPS 2-1/2 (DN 65) and larger connections.

Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.5 <u>HANGER AND SUPPORT INSTALLATION</u>. Pipe hanger and support devices are specified in Section 15140 - "Pipe Hangers and Supports."

Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).

NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).

NPS 2-1/2 and NPS 4 (DN 80 and DN 100): Maximum span

Install hangers for horizontal corrugated, stainless-steel tubing with the following maximum spacing and minimum rod sizes:

NPS 3/8 and NPS 1/2 (DN 10 and DN 15): Maximum span, 48 inches (1219 mm); minimum rod size, 3/8 inch (10 mm).

NPS 3/4 and NPS 1 (DN 20 and DN 25): Maximum span, 72 inches (1829 mm); minimum rod size, 3/8 inch (10 mm).

Option: Support tubing from structure according to manufacturer's written instructions.

3.6 <u>CONNECTIONS</u>. Install piping adjacent to appliances to allow service and maintenance. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches (1800 mm) of each appliance. Install union downstream from valve.

3.7 <u>FIELD QUALITY CONTROL</u>. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

End of Section

SECTION 15200

STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 SCOPE. this Section covers the installation of Low Pressure steam (less than 15 psig) and condensate steel piping together with fittings, specials and appurtenances for the services as indicated in the contract documents. Pipe and tubing shall be furnished complete with all fittings, flanges, unions and other accessories specified herein.

Pipe supports, anchors and expansion joints shall be furnished by Contractor, and are covered in Master Specifications Section 15140, Pipe Supports.

1.2 PERFORMANCE REQUIREMENTS. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

LP Steam Piping: 15 psig

Condensate Piping: Gravity at 250 deg F.

Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.3 SUBMITTALS.

1.3.01 Product Data. For each type of the following:

Pressure-reducing and safety valves.

Steam traps.

Thermostatic air vents and vacuum breakers.

Steam and Condensate piping.

Strainers, fittings, and valves.

1.3.02 Shop Drawings. Submittal of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

1.3.03 Reports. Field quality-control test reports.

1.3.04 O & M. Operation and maintenance data.

1.4 QUALITY ASSURANCE.

1.4.01 ASME Compliance. Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS.

2.1.01 Steel Pipe. ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

2.1.02 Cast-Iron Threaded Fittings. ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

2.1.03 Malleable-Iron Threaded Fittings. ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

2.1.04 Malleable-Iron Unions. ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

2.1.05 Cast-Iron Threaded Flanges and Flanged Fittings. ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

2.1.06 Stainless-Steel Bellows, Flexible Connectors.

Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.

End Connections: Threaded or flanged to match equipment connected.

Performance: Capable of 3/4-inch misalignment.

CWP Rating: 150 psig.

Maximum Operating Temperature: 250 deg F.

2.2 JOINING MATERIALS.

2.2.01 Pipe-Flange Gasket Materials. Suitable for chemical and thermal conditions of piping system contents.

ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2.2.02 Flange Bolts and Nuts. ASME B18.2.1, carbon steel, unless otherwise indicated.

2.2.03 Solder Filler Metals. ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.2.04 Brazing Filler Metals. AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.3 DIELECTRIC FITTINGS.

2.3.01 Description. Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

2.3.02 Insulating Material. Suitable for system fluid, pressure, and temperature.

2.3.03 Dielectric Unions.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Capitol Manufacturing Company.
Central Plastics Company.
Hart Industries, International Inc.
Watts Water Technologies, Inc.
Zurn Plumbing Products Group.
Or acceptable equal.

Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2.4 VALVES.

2.1.01 Gate, Globe, Check, Ball, and Butterfly Valves. Comply with requirements specified in Division 15, Valve Sections 15091, 15092, 15093 & 15096.

2.5 STRAINERS.

2.5.01 Y-Pattern Strainers.

Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.

End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.

Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.

Tapped blow-off plug.

CWP Rating: 250-psig working steam pressure.

2.6 SAFETY VALVES.

2.6.01 Bronze or Brass Safety Valves.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Armstrong International, Inc.
Kunkle Valve; a Tyco International Ltd. Company.
Spirax Sarco, Inc.
Watts Water Technologies, Inc.
Or acceptable equal.

Disc Material: Forged copper alloy.

End Connections: Threaded inlet and outlet.

Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

Pressure Class: 250.

Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6.02 Cast-Iron Safety Valves.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Armstrong International, Inc.
Kunkle Valve; a Tyco International Ltd. Company.
Spirax Sarco, Inc.
Watts Water Technologies, Inc.
Or acceptable equal.

Disc Material: Forged copper alloy with bronze nozzle.

End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.

Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.

Pressure Class: 250.

Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.

Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.7 PRESSURE-REDUCING VALVES.

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Armstrong International, Inc.
Hoffman Specialty; Division of ITT Industries.
Leslie Controls, Inc.
Spence Engineering Company, Inc.
Spirax Sarco, Inc.
Or acceptable equal.

Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

Body: Cast iron.

End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

Trim: Hardened stainless steel.

Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

Gaskets: Non-asbestos materials.

2.8 STEAM TRAPS.

2.8.01 Inverted Bucket Traps.

Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong TVS-2011S, stainless steel inverted bucket trap with integral isolation valves, strainer and test valve, or a comparable product by one of the following:

Armstrong International, Inc.
Barnes & Jones, Inc.
Dunham-Bush, Inc.
Hoffman Specialty; Division of ITT Industries.
Spirax Sarco Inc.
Or approved equal

Body and Cap: Stainless steel ASTM A240 Grade 304L.

Connection size: 3/4” NPT

Orifice size: 5/32” NPT

End Connections: Threaded.

Head and Seat: Stainless steel.

Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.

Bucket: Stainless steel.

Strainer: Integral stainless-steel inlet strainer within the trap body.

Air Vent: Stainless-steel thermostatic vent.

Pressure Rating: 400 psig.

2.9 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS.

2.9.01 Thermostatic Air Vent/Vacuum Breaker.

Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong TVAB-3, stainless steel combination Thermostatic Air Vent/Vacuum Breaker, or a comparable product by one of the following:

Armstrong International, Inc.
Barnes & Jones, Inc.
Dunham-Bush, Inc.
Hoffman Specialty; Division of ITT Industries.
Spirax Sarco, Inc.
Or acceptable equal.

Body: 304-L Stainless steel

End Connections: Threaded 304 stainless steel

Thermostatic Air Vent: 3/4” NPT

Vacuum Breaker: 3/8” NPT

Valve: Stainless steel

Spring: T302 stainless steel

“O” Ring: EPDM
Screen: Stainless steel

Thermostatic Element: Phosphor-bronze bellows in a stainless-steel cage

Vacuum Breaker Body: T303 stainless steel

Maximum Allowable Pressure: 300 psig @ 365°F

Maximum Operating Pressure: 150 psig

Discharge Orifice Size: 3/16”

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS.

3.1.01 Low Pressure Steam Piping. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.1.02 Condensate Piping above Grade. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.1.03 Condensate Piping below Grade. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.2 ANCILLARY PIPING APPLICATIONS

3.2.01 Air-Vent Piping.

Inlet: Same as service where installed.

Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

3.2.02 Vacuum-Breaker Piping: Outlet, same as service where installed.

3.2.03 Safety-Valve-Inlet and -Outlet Piping. Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 VALVE APPLICATIONS. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.4 PIPING INSTALLATION. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

Install piping to permit valve servicing.

Install piping free of sags and bends.

Install fittings for changes in direction and branch connections.

Install piping to allow application of insulation.

Select system components with pressure rating equal to or greater than system operating pressure.

Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

Reduce pipe sizes using eccentric reducer fitting installed with level side down.

Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.

Install valves according to Division 15 Section "Valves."

Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections

of equipment, and elsewhere as indicated.
Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blow-down connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 15, “Sections 15065 & 15140."

Identify piping as specified in Division 15, Section 15200 – Mechanical Identification.

Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

> On straight runs with no natural drainage points, install drip legs at intervals not exceeding 500 feet, if possible.
>
> Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

3.5 STEAM-TRAP INSTALLATION. Install steam traps in accessible locations as close as possible to connected equipment.

Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.6 PRESSURE-REDUCING VALVE INSTALLATION. Install pressure-reducing valves in accessible location for maintenance and inspection.

Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

Install gate valves on both sides of pressure-reducing valves.

Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 15, “Section 15130."

Install strainers upstream for pressure-reducing valve.

Install safety valve downstream from pressure-reducing valve station.

3.7 SAFETY VALVE INSTALLATION. Install safety valves according to ASME B31.9, "Building Services Piping."

Pipe safety-valve discharge without valves to atmosphere outside the building. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.8 HANGERS AND SUPPORTS. Install hangers and supports according to Division 15 “Section 15140 - Pipe Supports. Comply with requirements below for maximum spacing.

3.9 PIPE JOINT CONSTRUCTION. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube," using copper-phosphorus brazing filler metal complying with AWS A5.8.

Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

> Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
>
> Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.10 TERMINAL EQUIPMENT CONNECTIONS. Size for supply and return piping connections shall be the same as or larger than equipment connections.

Install traps and control valves in accessible locations close to connected equipment.

Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

Install vacuum breakers downstream from control valve, close to coil inlet connection.

Install a drip leg at coil outlet.

3.11 FIELD QUALITY CONTROL. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

Leave joints, including welds, un-insulated and exposed for examination during test.

Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

Flush system with clean water. Clean strainers.

Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

Perform the following tests on steam and condensate piping:

Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.

After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.

Prepare written report of testing.

End of Section

SECTION 15245

VIBRATION ISOLATION

PART 1 - GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of vibration isolation requirements associated with mechanical equipment. Schedules and notes on drawings indicate specific types of isolators required for each equipment.

1.2 GENERAL.

1.2.01 Governing Standards.

ASHRAE (HVACA) – ASHRAE Handbook – HVAC Applications

ASHRAE Refrigeration Handbook

ASTM A 36/A 36 M – Standard Specification for Carbon Structural Steel

1.3 SUBMITTALS.

1.3.01 Shop Drawings. Submit shop drawings for each type of vibration isolator for Engineer's review.

1.3.02 Product Data. Submit product data for vibration isolators indicating the following:

Equipment requiring isolation.

Spring outside diameters.

Free, operating, and solid heights.

1.4 QUALITY ASSURANCE. Isolation materials manufacturer shall be responsible for proper selection of spring rates to accomplish scheduled minimum static deflections, for all spring and pad type isolators, based on weight distribution of equipment requiring isolation.

Refer to Equipment Schedules.

Isolation materials manufacturer shall be responsible for structural design of steel beam bases and concrete inertia bases to support mechanical equipment scheduled to receive supplementary base.

Complete set of reviewed shop drawings of all mechanical equipment to receive vibration isolation devices shall be furnished to vibration isolation materials manufacturer, upon which selection of vibration isolators and design of supplementary bases will be completed.

1.5 WARRANTY. Manufacturer's standard warranty unless noted otherwise.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS.

2.1.01 Selection Criteria. Select vibration isolators for actual load imposed, and in accordance with Table, Selection Guide for Vibration Isolation, in the Sound and Vibration Control chapter of the ASHRAE HVACA.

Scheduled or specified static deflection requirements relate to actual static deflection of individual mounts under their particular loads.

Unacceptable vibration isolator mounts include:

> Vibration isolator mounts selected on the basis of cataloged, nominal static, deflection, while ignoring decrease in isolation efficiency due to loadings to less than those of nominal rating.
>
> Isolator mounts loaded in excess of their rated load capacity.
>
> Isolators selected by equally dividing total weight of equipment by proposed number of isolators. Except where supported equipment is symmetrical about its vertical axis.

Isolator springs shall have ratio of horizontal to vertical spring constants of not less than 0.8, be horizontally unrestrained, of diameter not less than 80 percent of height at rated load and allow reserve travel of 50 percent of rated deflection from height at rated load to shorted turns condition.

Elastic limit of springs shall not be exceeded at shorted turns conditions.

Equip isolator mounts having steel springs with means for leveling suspended equipment.

2.1.02 Floor Mounts. Equip with leveling bolts and locknuts.

Select for convenient bolting of base plates to building structure.

2.1.03 Hanger Mounts. Furnish positioning type hanger isolators that allow installation of equipment and piping at a fixed elevation independent of load changes and subsequent transfer of suspension load to springs.

Option, preloaded hanger isolators may be furnished with preloading devices being backed off after installation.

2.1.04 Coating. Dip coat steel elements of outdoor isolators with weather resistant paint.

2.1.05 Equipment Bases and Rails.

Type A, Concrete Inertia Block Mount.

Concrete inertia block base with steel springs mounted in series with ribbed neoprene pads.

Form concrete sub-bases from prefabricated steel pouring form frames with 1 inch by 1 inch by 1/8 inch angle stiffeners crossed in both directions on 9 inch centers and welded to sides of steel frames, templates to fit equipment anchor bolts, outboard height saver brackets, and spring isolators.

Depth of steel frame shall be not less than 1/12 of its longest span, but not less than 8 inches.

Concrete: 4000 psi, reinforcing steel #4 bars, 12 inches on center each way.

Acceptable Manufacturers:

Korfund Dynamics, Type RCPF with WS mounts.

Mason Industries, Type KSL with SLFH mounts.

Kinetics, Model CIB-H with FDS bolt down mounts.

Vibration Eliminator, Type SN with OST or OSK mounts.

Vibration Mountings and Controls, Type SPF with AEH mounts.

Type B, Structural Steel Base Mounting.

Structural steel base with steel springs mounted in series with elastomer pads or mounts.

Acceptable Manufacturers:

Korfund Dynamics, Spring-Isolated Structural Base with Type WS mounts.

Mason Industries, Type MSL with Type SLFH mounts.

Kinetics, Model SFB with FDS bolt down mounts.

Vibration Eliminator, Type OSK with OST or OSK mounts.

Vibration Mountings and Controls, Type WFB with Type AWH mounts.

Type C, Structural Steel Base Mount.

Structural steel base with double deflection neoprene-in-shear mounts.

Acceptable Manufacturers:

Korfund Dynamics, Structural Base with Type F or H mounts.

Mason Industries, Type MND with ND mounts.

Kinetics, Model SFB with Model RD mounts.

Vibration Eliminator, Type C or D.

Vibration Mountings and Controls, Type WFB with Type RD mounts.

2.1.06 Vibration Isolator Mountings.

Type D, Spring Floor Mount.

Individual steel spring mounts supported on elastomer pads.

Acceptable Manufacturers:

Korfund Dynamics, Type WS Bolt Down Design.

Mason Industries, Type SLFH.

Kinetics, Model FDS Bolt Down Mounts.

Vibration Eliminator, Type OST.

Vibration Mountings and Controls, Type AWH.

Type E, Double Spring Floor Mounts with Lift Restraint.

Double, side-by-side spring mounts with lift restraints, and supported on elastomer pads.

Acceptable Manufacturers:

Korfund Dynamics, Type WSCL.

Mason Industries, Type SLR.

Kinetics, Model FLS.

Vibration Eliminator, Type KW.

Vibration Mountings and Controls, Type AWR.

Type F, Neoprene-In-Shear Floor Mount.

Individual double deflection neoprene-in-shear mounts.

Acceptable Manufacturers:

Korfund Dynamics, Type F.

Mason Industries, Type ND.

Kinetics, Model RD.

Vibration Eliminator, No. 140 or No. 240.

Vibration Mountings and Controls, Type RD.

Type G, Neoprene Pad Floor Mount.

Ribbed or waffle pattern neoprene pads, single or multilayered as required for equipment's static deflection.

Acceptable Manufacturers:

Korfund Dynamics, Korpad.

Mason Industries, Type WSW or Super W.

Kinetics,Model NP or NG.

Vibration Eliminator, Type 100N.

Vibration Mountings and Controls, Shear-Flex.

Type H, Combination Spring and Neoprene-In-Shear Hanger Mount.

Hanger isolators with steel springs mounted in series with elastomer elements.

Acceptable Manufacturers:

Korfund Dynamics, Type VSPL.

Mason Industries, Type PC30N.

Kinetics,Model SRHPL.

Vibration Eliminator, Type PCSR.

Vibration Mountings and Controls, Series RSHP.

Type J, Neoprene-in-Shear Hanger Mount.

Hanger isolators with elastomer elements.

Acceptable Manufacturers:

Korfund Dynamics, Type H.

Mason Industries, Type HD.

Kinetics, Model RH.

Vibration Eliminator, C Series.

Vibration Mountings and Controls, Series RHDC.

Type K, Thrust Restraint.

Thrust restraint, having spring with elastomer element mounted in series, housing, rods, brackets, and means for presetting thrust force.

Acceptable Manufacturers:

Korfund Dynamics, Thrust Restraints.

Mason Industries, Type WB.

Kinetics, Thrust Restrainer.

Vibration Eliminator, Thrust Restraints.

Vibration Mountings and Controls, SH-27.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.1 General. Install vibration isolation materials and equipment bases in accordance with manufacturer's written instructions.

Remove debris trapped between equipment bases and floor.

Level mountings so each mount carries assigned load.

Mounts showing evidence of insufficient or excessive loading, buckling, squirming, totally collapsed springs, making permanent contact with _lift or sag restraints, or shorted springs and elastomer elements will not be accepted.

Install hanger type isolators so no shorting will occur via contact between upper and lower hanger rods or via contact between lower hanger rods and isolator boxes.

Locate floor vibration isolator mounts so base plates are supported in horizontal position by floor slabs, beams, or other structural elements.

Isolator placements resulting in overhanging or tilted base plates or in bending stresses in steel plate or bar grate flooring are unacceptable.

Bolt base plates to supporting structure.

Prepare pouring forms of inertia bases for concrete placement in accordance with manufacturer's instructions.

Make provisions for bond breaking between concrete fill and floor structure.

Vibrate concrete in place to ensure uniform filling.

Carefully remove spilled concrete.

Remove shipping bolts and blocks from isolator mounts.

Jack spring leveling bolts to obtain full floating equipment suspension.

Level vibration isolator mounts and bases, to attain fully floating equipment suspension under loading conditions of actual operation and adjust restraints.

Adjust or replace defective elements as required.

After installation of isolation materials and before start-up of equipment, clear debris from areas surrounding and beneath isolated equipment.

No rigid connections between equipment and building structure shall be made that degrades noise and vibration isolation system.
Electrical conduit connections to isolated equipment shall be installed with slack to allow free motion of isolated equipment.

3.2 APPLICATION OF MOUNTING TYPES.

Mountings: Types scheduled on Drawings.

Static deflection requirements: Where not indicated, defined in ASHRAE HVAC Systems and Applications Handbook.

Ductwork located within 50 feet of connections to air handling units: Support with Type H vibration isolators selected for a static deflection of 0.75 inch.

Fans and air handling units: At flexible connections install Type K thrust restraints, where developed aerodynamic thrust exceeds 10 percent of weight, and where fan static pressure exceeds 5 inches water gauge.

End of Section

SECTION 15250

MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of insulation, jackets accessories for mechanical piping, ductwork and equipment. Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.

1.2 GENERAL. Materials furnished and installed under this section shall be in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall be responsible for coordinating the installation of insulation with the installation of the piping, ductwork, and equipment to be insulated. The piping, ductwork, and equipment shall be tested and accepted by Engineer before installation of the insulation materials.

Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.

All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials provided under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL, NFPA, and ASTM safety requirements.

1.2.04 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.05 Surface Burning Characteristics. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.

1.2.06 Painting and Identification. Field painting and identification shall be as specified inMaster Specification Section 09900, Painting.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.

1.4 QUALITY ASSURANCE.

1.4.01 Manufacturer Experience. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance withMaster Specification Section 01180, Equipment, Materials, Parts, and Tools .

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.2 MATERIALS.

2.2.01 Pipe Insulation.

2.2.01.01 Type PMF1 Insulation. Type PMF1 mineral fiber pipe insulation shall be Schuller "Micro-Lok", Knauf "Pipe Insulation" Owens/Corning, or approved equal.

Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F (-18°C to 454°C), shall have a maximum thermal conductivity (k) of 0.24 BTU in/hr ft^2 °F at 75°F (0.035 W/m °C at 24°C), and shall conform to ASTM C547.

2.2.01.02 Type PMF2 Insulation. Type PMF2 high temperature mineral fiber pipe insulation shall be Fibrex "Epitherm 1200", or approved equal.

Type PMF2 pipe insulation shall be a high temperature, sectional or segmented mineral fiber forms with thermosetting binder suitable for temperatures up to 1200°F (649°C), and shall be provided in multiple layers. Fittings and valves shall be insulated with factory-made molded fiber fittings or built-up sections of pipe covering. The insulation shall conform to ASTM C547.

2.2.01.03 Type PFC1 Insulation. Type PFC1 flexible cellular elastomeric pipe insulation shall be Armstrong "Armaflex", Rubatex "R-180-FS", or approved equal. Flexible cellular polyolefin foam insulation shall be IMCOA "Imcolock" or “Imcoshield", or approved equal.

Type PFC1 pipe insulation shall be one-piece, molded elastomeric or polyolefin foam insulation suitable for a temperature range of -40°F to 210°F (-40°C to 99°C), and shall have a maximum thermal conductivity (k) of 0.28 BTU in/hr ft^2 °F at 75°F (0.040 W/m °C at 24°C). The insulation shall be suitable for exposure to weather and direct sunlight or, where not indicated to be jacketed, shall be given two coats of an ultraviolet-resistant finish recommended by the manufacturer. The insulation shall conform to ASTM C534.

2.2.02 Duct Insulation.

2.2.02.01 Type DMF1 Insulation. Type DMF1 semi-rigid type duct insulation shall be Schuller "800 Series Spin-Glas", Knauf "Insulation Board", Owens/Corning, or approved equal.

Type DMF1 exterior insulation for rectangular ductwork shall be a semirigid, 3 pound per cubic foot (48 kg/m^3) density fiberglass material with a factory-applied all service jacket. The insulation shall conform to ASTM C612.

2.2.02.02 Type DMF2 Insulation. Type DMF2 flexible type duct insulation shall be Schuller "Microlite", Knauf "Duct Wrap", Owens/Corning, or approved equal.

Type DMF2 exterior insulation for round ductwork shall be 1 pound per cubic foot (16 kg/m^3) density flexible fiberglass duct wrap with factory-applied foil-scrim-kraft facing. The insulation shall conform to ASTM C553.

2.2.03 Equipment Insulation.

2.2.03.01 Type EMF1 Insulation. Type EMF1 equipment insulation shall be Schuller "800 Series Spin-Glas", Knauf "Insulation Board", Owens/Corning, or approved equal.

Type EMF1 equipment insulation shall be rigid mineral fiber insulation board with a density of 6 pounds per cubic foot (96 kg/m^3) and a factory-applied foil-scrim-kraft facing. The insulation shall conform to ASTM C612.

2.2.03.02 Type EMF2 Insulation. Type EMF2 equipment insulation shall be Fibrex "Mineral Fiber Blanket", or approved equal.

Type EMF2 equipment insulation shall be high temperature mineral fiber blanket with a thermosetting binder suitable for temperatures up to 1200°F (649°C) and shall have a density of 8 pounds per cubic foot (128 kg/m^3). The insulation shall conform to ASTM C592.

2.3 ACCESSORIES.

2.3.01 PVC Insulation Jackets. PVC insulation jackets for piping systems shall be furnished and installed as specified herein and indicated on the drawings.

All fittings in piping systems insulated with mineral fiber shall be jacketed with a polyvinyl chloride (PVC) jacketing material. Piping systems where indicated to have PVC jackets shall be jacketed with the same PVC jacketing material. Jackets for fittings shall be one piece, factory molded to the contour of the fitting. The PVC jacket and fitting covers shall have a minimum thickness of 0.02 inches (0.51 mm) when installed indoors and 0.03 inches (0.76 mm) when installed outdoors. PVC jacketing shall be Schuller "Zeston 2000 Series", or approved equal.

2.3.02 Aluminum Insulation Jackets. Aluminum insulation jackets for insulated piping systems shall be furnished and installed as required and indicated on the drawings.

Fittings in insulated piping systems and equipment where indicated in the insulation schedule shall be provided with aluminum jackets of the same aluminum jacketing material as the piping systems. The aluminum jacket shall be Alclad 3004, or approved equal complying with ASTM B209. The jacket shall have a nominal thickness as indicated, with an embossed finish. A factory-applied asphalt and kraft paper vapor barrier or polyethylene film and kraft paper vapor barrier shall extend the full width of the jacket.

PART 3 - EXECUTION

3.1 INSTALLATION.

3.1.01 General. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment, as required, that are not factory insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.

Seams of exposed insulation and jackets shall be in the least visible location.

3.1.02 Piping Insulation.

3.1.02.01 Type PMF1 Insulation. Pipe insulation shall be installed to cover all piping, fittings, and appurtenances. Insulation shall be full length of the factory unit using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.

Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet (4.6 m) for straight runs and not more that 6 inches (150 mm) from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.

On piping 2 inches (50 mm) and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

3.1.02.02 Type PMF2 Insulation. The insulation shall be installed in layers as required to obtain the specified thickness. Joints and seams between insulation sections or segments shall be tight and shall be staggered between layers. The insulation shall be shall be fastened with stainless steel wire loops on 6 inch

(150 mm) centers embedded into the outer layer. All cracks, voids, and depressions shall be filled with insulating cement suitable for the system operating temperatures. The surfaces to receive outer coverings shall be smooth and uniform. Flanges and expansion joints in exhaust piping shall not be insulated.

3.1.03 Duct Insulation. Insulation for ducts indicated on the drawings as wrapped shall be installed as specified herein and indicated on the drawings. Duct insulation shall be continuous through hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.

Insulation on ducts conveying air at temperatures below 60°F (16°C) shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.

3.1.03.01 Type DMF1 Insulation. Type DMF1 semirigid insulation shall be secured to all four sides of the duct with mechanical fasteners, spaced not more than 12 inches (305 mm) apart and not more than 3 inches (76 mm) from the edges of the insulation joints. At least two rows of fasteners shall be provided for each side of 12 inch (305 mm) and larger ducts, and one row for each side of ducts smaller than 12 inches (305 mm). All joints in the insulation shall be sealed with 3 inch (76 mm) wide joint sealing tape or 4 inch (102 mm) wide strips of jacket material secured with adhesive and staples.

3.1.03.02 Type DMF2 Insulation. Type DMF2 flexible insulation shall be installed with waterproof, fire-retardant adhesive. Insulation jackets shall overlap at least 2 inches (51 mm) and shall be secured under the overlap with adhesive and stapled on 4 inch (102 mm) centers.

3.1.04 Equipment Insulation. Insulation for equipment shall be installed as specified herein and indicated on the drawings. Equipment insulation shall be installed and fastened as recommended by the manufacturer.

Equipment insulation shall be installed in as closest contact possible with the equipment surface and shall be secured with studs, pins, clips, adhesives, wires, or bands. Pumps may be insulated by forming a box around the pump housing. Seams shall be sealed with joint sealing tape. A smooth coat of insulation cement shall be applied over the insulation except at removable sections. On equipment with surface temperatures lower than 60°F (16°C), two coats of vapor barrier coating shall be applied.

Equipment insulation shall be applied with interruptions for access to manholes, flanges, and other openings without disturbing the insulation. Boxouts with beveled and sealed edges shall be provided around code stamping symbols and nameplates.

3.1.05 PVC Jacketing. PVC jacketing for piping systems shall be installed as specified herein and indicated on the drawings. End joints and longitudinal seams on piping systems conveying fluids at lower than ambient temperatures shall be vapor-sealed, and covered with vapor-barrier tape to ensure a continuous vapor seal. Fittings shall be insulated with glass fiber material.

3.1.06 Aluminum Jacketing. Aluminum jacketing for piping systems shall be installed as specified herein and indicated on the drawings. Jacketing shall be held in place with stainless steel securing bands uniformly spaced at not more than 18 inches (457 mm) to produce tight joints without "bulging". The jacket shall overlap at least 2 inches (51 mm) at longitudinal and circumferential joints. Joints shall be overlapped and sealed with caulk to prevent moisture penetration, and longitudinal joints shall be placed to shed water. Exposed ends of pipe insulation shall be provided with covers constructed of the same material as the jacketing.

Elbows shall be jacketed with spirally wrapped aluminum strips or individual mitered segments or gores cut to fit the insulation.

3.2 INSULATION SCHEDULE.

INSULATION SCHEDULE				
Service	Size Inches (mm)	Mechanical Insulation		Notes
		Type	Thickness Inches (mm)	
PIPING - INDOOR (CONCEALED OR EXPOSED)				
Chilled Water	All	PMF1	1 (25)	(3)
Compressed Air	All	PMF1	1 (25)	(2)
Condensate Drain	All	PMF1	1 (25)	(4)

Digester Gas	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1 (25) 2 (50)	
Engine Exhaust	All	PMF2	Note (8)	
Gaseous Oxygen	All	PFC1	2 (50)	
Heating Water, Steam, and Steam Condensate	Up to 3/4 (20) 1 to 2 (25 to 50) 2.5 to 4 (65-100) 6 & 8 (150-200) 10 (250) & larger	PMF1 PMF1 PMF1 PMF1 PMF1	1-1/2 (40) 1-1/2 (40) 2 (50) 2-1/2 (65) 3 (80)	(3) (3) (3) (3) (3)
NaOH, $FeCl_3$ Without Heat Tracing	All	PMF1	1 (25)	(2)
Potable Cold Water	Up to 3 (80) 4 (100) & larger	PFC1 PFC1	3/4 (20) 1/2 (15)	(4) (4)
Potable Hot Water	All	PMF1	1 (25)	
Process Air, Nitrogen, and Gaseous Oxygen From VPSA System Including Piping From Blower Inlet Filter To Ozone Generator Inlet and Common Header From VPSA and LOX	Up to 6 (150) Larger than 6 (150)	PMF1 PMF1	1 (25) 2 (50)	(2) (2)
Refrigerant Suction	Up to 1 (25) 1-1/4 (32) & larger	PFC1 PFC1	3/4 (20) 1 (25)	(3) (3)

Sludge	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1-1/2 (40) 2 (50)	(3) (3)
Storm Drain	All	PFC1	3/4 (20)	(4), (9)
PIPING - OUTDOOR (EXPOSED)				
Compressed Air	All	PMF1	1 (25)	(2), (5)
Digester Gas	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1 (25) 2 (50)	
Fuel Oil	All	PMF1	1-1/2 (40)	
Gaseous Oxygen	All	PFC1	2 (50)	
NaOH, $FeCl_3$ Without Heat Tracing at 60°F+	All	PMF1	1 (25)	(2)
NaOH, $FeCl_3$ Without Heat Tracing at 30°F+	All	PMF1	1-1/2 (40)	(2)
NaOH, $FeCl_3$ Without Heat Tracing at 0°F+	All	PMF1	2 (50)	(2)
Process Air	All	PMF1	1 (25)	
Refrigerant Suction	All	PFC1	1 (25)	(2)
Sludge	Up to 2 (50) Larger than 2 (50)	PMF1 PMF1	1-1/2 (40) 2 (50)	(2) (2)
DUCTWORK				
Rectangular	All	DMF1	1 (25)	(6), (7)

Round	All	DMF2	2 (50)	(6), (7)
EQUIPMENT				
Air Separators	All	EMF1	1-1/2 (40)	
Chilled Water Pumps	All	EMF1	1-1/2 (40)	
Engine Silencer	All	EMF2	Note (8)	
Expansion Tanks	All	EMF1	1-1/2 (40)	
Heating Water Pumps	All	EMF1	1-1/2 (40)	

Mechanical Insulation Types: FC - Flexible Cellular
MF - Mineral Fiber

Notes:

(1) PVC jacket.

(2) Aluminum jacket.

(3) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet (2.4 m) above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.

(4) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.

(5) Insulation shall be provided for exposed portions of the piping system located less than 8 feet (2.4 m) above the finished floor or grade.

(6) Insulation shall be provided for outside air plenums and ducts with heating coils which are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.

(7) Insulation shall be provided for air conditioning supply ducts, air

conditioning return ducts, and dehumidifier reactivation air discharge ducts, unless indicated to be internally lined.

(8) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F (66°C).

(9) The underside of all roof drains shall be insulated to a 1 foot (300 mm) radius from the center of the drain. All roof drain piping within 4 feet (1.2 m) of the drain shall be insulated.

Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F (60°C) and below 60°F (15°C) shall be insulated.

End of Section

SECTION 15300

FIRE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of materials, equipment, and appurtenances associated with wet-pipe and dry-pipe fire sprinkler systems. All labor, materials, tools, equipment, service and supervision required to design, install, test, and place the fire sprinkler systems in service shall be provided.

Fire sprinkler systems shall meet the design conditions and features as specified and as indicated on the drawings.

1.2 GENERAL.

1.2.01 Coordination. Piping, equipment, and appurtenances furnished and installed under this section shall be designed, fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations furnished by the manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the fire sprinkler system is compatible with all other parts of the system; that all piping, equipment, and appurtenances are appropriate for the intended function; and that all devices necessary for a properly functioning system have been provided.

Equipment and appurtenances furnished under this section shall be the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the products of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall become familiar with details of the work, shall verify dimensions in the field, and notify Engineer of any discrepancy before performing the work.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with the applicable national, state, and local codes and ordinances, laws, regulations, and NFPA Standards which pertain to such work. In case of a conflict between these specifications and any applicable national, state, or local code, ordinance, law, regulation, or NFPA Standard, the latter shall govern.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming a part of the equipment and appurtenances furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

The data and specifications submitted shall include, but not be limited to, the following:

Design Documents

Complete working plans, hydraulic calculations, water supply data, and information required by NFPA Standards.

Equipment, Piping, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection type, size, and location.

Wiring diagrams.

Pressure loss data.

Net weight.

Test Reports

Test reports and certificates as described in NFPA Standard No 13.

1.3.02 Operation and Maintenance Manuals. Operation and maintenance instructions shall be provided for the equipment and appurtenances furnished under this section.

1.4 QUALITY ASSURANCE. All materials and work shall conform to the requirements of the National Fire Protection Association (NFPA), Factory Mutual (FM), and Underwriters' Laboratories (UL).

Manufacturer's providing equipment and appurtenances shall be listed by product name and manufacturer in the UL Fire Protection Equipment Directory and FM Approval Guide.

Fire sprinkler system materials shall be permanently stamped or labeled with the Listing and Approval Agency's identification.

Materials, installation, inspection, and testing of the fire sprinkler system shall comply with the requirements of the local authorities having jurisdiction and Owner's insurance underwriter.

The sprinkler system drawings and calculations shall be performed by an individual with National Institute for Certification of Engineering Technologies (NICET) III certification and signed and sealed by a registered professional engineer licensed in the state of Michigan.

The fire sprinkler system shall be installed by a firm having previously installed a minimum of five systems similar in size and scope to this project.

1.5 PERFORMANCE AND DESIGN REQUIREMENTS. All piping, equipment, and appurtenances shall be designed to meet the performance and design conditions as specified herein and on the drawings. The system shall be designed as an automatic wet-pipe or automatic dry-pipe sprinkler system as indicated in Schedule 13930-S01. The system type, zoning, hazard classification, sprinkler density, and design area of operation shall be as indicated on the drawings, or on schedules, as indicated.

The design area represents the minimum area to be considered for hydraulic calculations. The system shall be designed to discharge the sprinkler density over the most hydraulically demanding design area. The area required to be sprinkled may be larger than the design area.

Water allowances shall be made for inside or outside hose streams as required. Hose stream flow rates shall be as specified by NFPA Standards.

1.5.01 Flow Test. Sprinkler system design shall be performed using either data from a test performed by Contractor, or data supplied by Engineer.

When indicated, Contractor shall perform a water flow test to verify that adequate pressure is available at the required flow before the system is designed. Water supply information provided on the data sheet is based on estimates and shall be verified by flow test prior to designing the sprinkler system. The verification flow test and data shall be the responsibility of Contractor. If it is not possible to perform a flow test prior to designing the system, the test may be performed later, however, Contractor shall accept responsibility for any modifications required in the event that the flow tests indicate a lower available water supply than that on which the calculations were based.

1.5.02 Pipe Sizing. The sprinkler system shall be hydraulically calculated, and shall include a safety factor as indicated at the required flow.

Pipe and accessory sizes indicated on the drawings are the minimum allowed, and shall be increased if determined necessary by hydraulic calculations. The water velocity in piping systems shall not exceed 20 fps (6.1 m/s) at design flow.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.7 EXTRA MATERIALS. A supply of spare sprinklers shall be provided in accordance with NFPA Standard No 13. The sprinklers shall be stored in a suitable metal container and shall be representative of the number of each type and each temperature rating of the sprinklers installed.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment identification, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All components of the fire sprinkler system shall be designed to meet the specified conditions indicated in the Contract Documents.

2.2 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as indicated in the respective product description paragraphs.

2.3 MATERIALS. All piping systems and related components shall be rated for at least 175 psig (1207 kPa) working pressure.

2.3.01 Anchor Bolts and Expansion Anchors. All anchor bolts, expansion anchors, nuts and washers shall comply with UL, FM, and NFPA requirements. Powder-driven anchor assemblies shall not be used.

2.3.02 Piping Systems. Piping on the supply side of the backflow prevention device shall be as specified in other sections for potable water use. Piping on the sprinkler side of the backflow prevention device shall be black or galvanized steel pipe as follows:

Standard Weight ASTM A53 with Threaded Malleable or Cast Iron Fittings.

All 2 inch (51 mm) and smaller piping.

Standard Weight ASTM A53 with Flanged Fittings.

All 2-1/2 inch (63 mm) and larger piping.

Standard Weight ASTM A53 with Grooved-End Fittings.

All 2-1/2 inch (63 mm) and larger piping on the sprinkler side of the backflow preventer. (Optional)

Schedule 10 ASTM A135 with Roll-Grooved Fittings.

All 2-1/2 inch (63 mm) and larger piping on the sprinkler side of the backflow preventer. (Optional)

Galvanized steel pipe shall be used for sprinkler piping in the systems and locations as required. Pipe shall be furnished complete with all fittings, jointing materials, supports and anchors, and other accessories required for a complete system.

Plain-end fittings with mechanical devices which grip into the pipe, and saddle type branch fittings shall not be used.

2.3.03 Pipe Supports. Pipe supports shall be suitable for the application, construction, and type and size of pipe used.

"C" type clamps shall be provided with retaining clips and shall not be used for piping larger than 1 inch (25 mm) size.

Galvanized hanger assemblies shall be used for the support of galvanized steel piping systems.

2.3.04 Service Valves. Service valves shall be UL-listed and FM approved, with 175 psig (1207 kPa) non-shock minimum working pressure rating.

2.3.04.01 Gate Valves. Gate valves in 2 inch (51 mm) and smaller sizes shall be cast-bronze with threaded ends, solid wedge disc, outside screw and yoke, and rising stem.

Gate valves in 2-1/2 inch (63 mm) and larger sizes shall be iron body, bronze mounted, with tapered solid wedge disc, outside screw and yoke, and rising stem. Valves shall be provided with replaceable bronze disc facing rings and flanged ends.

Gate valves in 4 inch (102 mm) and larger sizes for use with indicator posts shall be iron body, bronze mounted, with solid wedge disc, non-rising stem, operating nut, replaceable bronze disc facing rings, and bonnet cap for indicator post. Gate valves for use with wall indicator posts shall be provided with flanged ends. Gate valves for use with vertical indicator posts shall be provided with flanged or mechanical joint ends.

Indicator posts shall be wall type or vertical type, as indicated. When indicated, the indicator post shall be provided with a supervisory switch to alarm when the valve is not in the full open position.

Wall type indicator posts shall be with cast-iron body, windows for target plates that indicate valve position, extension rod and coupling, locking device, hand wheel operator, wall flange, and red enamel finish.

Vertical type indicator posts shall be with cast-iron body, ductile iron barrel, windows for target plates that indicate valve position, extension rod and coupling, locking device, operating wrench, and red enamel finish. The indicator post shall be of suitable length for the water main bury depth, with the operating handle located approximately 3 feet (900 mm) above finish grade.

2.3.04.02 Butterfly Valves. Butterfly valves in 3 inch (76 mm) and larger sizes shall be provided with cast iron body, iron or aluminum/bronze disc, BUNA-N or EPDM seat sleeve. Valve body shall be lug or grooved type as determined by the piping system. Butterfly valves shall be provided with an integral indicator to show disc position. The indicator shall include a pre-wired single-circuit supervisory switch rated for 10 amperes ac.

2.3.04.03 Ball Valves. Ball valves in 2 inch (51 mm) and smaller sizes shall be brass ball and body with reinforced Teflon seat and threaded ends.

2.3.04.04 Check Valves. Swing check valves 2-1/2 inch (63 mm) and larger shall be cast-iron body with bolted cap, bronze disc or cast-iron disc with bronze disc ring, and flanged ends.

2.3.05 Specialty Valves. Specialty valves shall be UL-listed and FM approved, with 175 psig (1207 kPa) non-shock minimum working pressure rating.

2.3.05.01 Alarm Check Valve. When an alarm check valve is indicated, it shall be provided with variable pressure trim and standard accessories including pressure gauges; alarm switch with contacts rated for 120 volts, 10 amperes; testing bypass;

drain cup; retarding chamber; and all necessary pipe, fittings, and accessories required for a complete trimming installation in accordance with NFPA No. 13. The valve shall be provided with flanged inlet and outlet, bronze grooved seat with O-ring seals, and single hinge pin and latch design. The alarm switch shall be wired to the fire alarm system.

2.3.05.02 Dry-Pipe Valve. When a dry-pipe valve is indicated, it shall be a latching differential valve and shall be provided with standard accessories including drip check valve; drain cup; reset bar; alarm test shut-off valve; pressure gauges; alarm switch with contacts rated for 120 volts, 10 amperes; testing bypass; and all necessary pipe, fittings, and accessories required for a complete trimming installation in accordance with NFPA No. 13. The valve shall be provided with flanged inlet and outlet, bronze grooved seat with O-ring seals, and single hinge pin and latch design. The alarm switch shall be wired to the fire alarm system.

An accelerator, anti-flood device, and associated trim package shall be provided with each dry-pipe valve.

2.3.05.03 Deluge Valve. The system deluge control valve shall be a listed indicating type valve. The control valve shall be UL listed and Factory Mutual (FM) approved for fire protection installations. The system control valve shall be rated for normal system pressure but in no case less than 175 psi. Acceptable manufacturers shall be Viking, Victaulic or approved equal.

The system valve shall be cast-iron body, hydraulically operated, differential-pressure type. Include bronze seat with O-ring seals, trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from drain line, fill-line attachment with strainer, and push-rod chamber supply connection.

Water Control Valve: The deluge system shall utilize a 90° pattern or straight type of deluge valve shall be externally resettable by hydraulic means. The deluge valve shall employ a positive vent on the priming line to ensure that the deluge valve will not prematurely reset. The inlet and outlet connections of deluge valve can be flanged by flanged, flanged by grooved or grooved by grooved, respectively. The deluge valve shall be capable of installation in the vertical or horizontal position. The deluge valve shall be UL Listed and Factory Mutual Approved. The deluge valve shall have a working pressure of 250 PSI. The valve trim shall be compatible and shall be installed following the manufacturer’s specifications. The Deluge Valve manufacturer shall be Viking E-1 or F-1 series or approved equal.

Water Control Valve Trim: The deluge valve trim shall incorporate a pressure operated relief valve (PORV) of the same manufacturer as the deluge valve, to provide a hydraulic means to positively vent the priming water chamber. All deluge valve trim piping and devices shall be listed for use as deluge system. The deluge valve trim shall be galvanized and rated for 250 PSI working pressure. The Deluge Valve Trim shall be compatible with Viking E-1 or F-1 deluge valve, or approved equal.

Water Control Valve Release Panel: The deluge valve release panel shall be 120 VAC or 220 VAC powered with a 24 hour D/C backup power supply. The deluge valve release panel shall be capable of accepting cross-zoned detection as the means of system release. The deluge valve release control panel shall conform to NFPA 70, NFPA 72 and all other applicable codes. The deluge valve release control panel shall be listed for use with a Viking Model E-1 or F-1 deluge valve. The Deluge Release Panel shall be a Simplex-Grinnell, Viking, or approved equal.

Solenoid Valve: An electric solenoid valve shall be utilized to release the priming chamber water pressure. The solenoid valve shall be 24 VAC and conform to NFPA 70. The Solenoid shall be listed for the use with Viking Model E-1 or F-1deluge valve, or approved equal.

Discharge Devices: Nominal 1/2-inch orifice for “Ordinary” temperature classification rating, unless otherwise indicated or required by application.

Open Sprinklers: UL 199, without heat-responsive element.

Orifice: 1/2-inch, with discharge coefficient K between 5.3 and 5.8.

Orifice: 17/32-inch, with discharge coefficient K between 7.4 and 8.2.

Supplemental Detection System: Electrical devices utilized in the supplemental detection system shall be compatible with the release control panel. Installation of electrical supplemental detection system shall be in accordance with N.F.P.A. 70, NFPA 72 and local installation requirements. The detection system shall be inspected, tested and maintained in accordance with all applicable standards and codes.

System Piping: System piping shall conform to NFPA 13, Standards for Installation of Sprinkler Systems. System piping shall be listed for the maximum system pressure it is to be exposed to. All system piping shall be metallic and shall be protected against corrosion of corrosive exist.

Hangers: Deluge sprinkler system hangers shall conform to NFPA 13, Standards for Installation of Sprinkler Systems. The system piping shall be substantially supported to prevent sway or thrust. The hanging of no-system components from the sprinkler piping shall be strictly prohibited. The use of non-metallic hanger materials shall be prohibited unless expressed otherwise.

Fittings: Pipe fittings installed on the deluge sprinkler system shall be in conformance with NFPA 13, Standards for Installation of Sprinkler Systems. The fittings shall be listed for use at the system pressures to be encountered. Fittings shall be corrosion resistant if they are to be installed in a corrosive atmosphere.

2.3.05.04 Air Maintenance Device. An air maintenance device shall be provided for each dry-pipe system. The air maintenance device shall be furnished as a complete assembly, including pressure regulator, pressure relief valve, strainer, shut-off valves, bypass valve, check valve, restriction device, and associated piping. The pressure reducing valve and pressure relief valve settings shall be suitable for the water system supply pressure.

2.3.05.05 Ball Drip Valves. Ball drip valves shall be automatic drain type, 3/4 inch (19 mm) body size, with spring-loaded ball check device and threaded ends.

2.3.05.06 Backflow Preventer. The sprinkler system backflow preventer shall be a double check, double check detector, reduced pressure principle, or reduced pressure detector type as required. The unit shall be epoxy-coated cast iron, with bronze seat and stainless steel trim. Gate valves with flanged ends, outside screw and yoke, rising stem, and resilient seats shall be factory installed at each end of the unit. Each gate valve shall be provided with a supervisory switch to alarm in the event that the valve is not in the full open position.

Detector type backflow preventers shall have a bypass consisting of a bronze displacement type water meter in series with a bronze backflow preventer with ball valves on the bypass line. The backflow preventer on the bypass line shall be double check or reduced pressure principle type as needed to match the primary unit. Backflow preventers shall be as manufactured by Febco, Watts Industries, Inc., or approved equal.

2.3.06 Automatic Sprinklers. Sprinklers shall be furnished and installed in accordance with their listed spacing limitations. Automatic sprinklers shall be provided with heat responsive elements conforming to UL 199. Sprinkler types and categories shall be as indicated in Schedule 13930-S01 or other location as required. Sprinklers shall be provided with nominal 1/2-inch orifice and 165°F (74°C) temperature rating unless otherwise indicated or required by application. Sprinklers located in the vicinity of heaters shall be provided with intermediate or high temperature ratings as specified by NFPA 13.

Sprinklers shall be furnished and installed with all required escutcheons for a complete installation. Escutcheons shall permit sprinkler head adjustment as needed for a proper installation.

Sprinkler cabinets shall be finished steel with hinged cover, space for minimum of 6 spare sprinklers plus sprinkler wrench, and shall be suitable for wall mounting.

Include number of sprinklers required by NFPA 13 and 1 wrench for sprinklers. A separate cabinet with sprinklers and wrench shall be provided for each style of sprinkler head on this project.

When indicated in Schedule 15300-S01, wire-cage type sprinkler guards shall be provided with fastening device for attaching to sprinkler.

2.3.07 Fire Department Connection. A sprinkler system fire department Siamese connection shall be provided when indicated on drawings. The location of the connection shall be as indicated on the drawings or as approved by Engineer and the local Fire Department. The type of siamese connections shall be wall-type or freestanding type as required.

Wall-type fire department connections shall be flush or a projecting type, as required, with cast-brass body; polished chrome plated finish; NH-standard thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS outlet. Connection shall include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet; and round wall escutcheon plate with marking "AUTO SPKR". The connection shall be provided with two 2-1/2 inch (65 mm) inlets and one 4 inch (100 mm) back outlet.

Freestanding type fire department connections shall be cast-brass or polished brass, as required, with angle body, polished brass cover sleeve, NH-standard thread inlets according to NFPA 1963 and matching local fire department threads, and threaded NPS outlet. Connection shall include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet, and cast brass identification nameplate with marking "AUTO SPKR". The connection shall be provided with two or three 2-1/2 inch (65 mm) inlets and one 4 inch (100 mm) or one 6 inch (150 mm) outlet, as required.

2.3.08 Alarm Devices. Alarm devices shall be provided as indicated. Alarm device type and size shall be as needed to match piping and equipment connections.

Water flow indicators shall be electrical supervision vane type, rated to 250 psig (1724 kPa gauge), and shall comply with UL 346. The indicators shall be furnished with a pipe saddle and cast aluminum housing, and shall be suitable for horizontal or vertical installation. Two spdt circuit switches shall be provided with isolated alarm and auxiliary contacts. Contacts shall be rated for 7 ampere, 125 V ac and 0.25 ampere, 24 V ac. Water flow indicators shall be complete with factory-set, field-adjustable, instantly recycling pneumatic retard element to prevent false signals, and tamper-proof cover that alarms when cover is removed.

Pressure switches shall be electrical supervision type, with spdt contacts, and shall comply with UL 753. The pressure switches shall be designed to signal water flow based on rising pressure.

Supervisory (tamper) switches shall comply with UL 753, and shall be electrical supervision type, with spdt normally closed contacts. The switches shall be designed to signal when the controlled valve is in other than full open position and if switch is removed or dismantled.

The sprinkler water flow alarm shall be water motor or electric type.

Water motor alarms shall be hydraulically operated outdoor alarm type. The water motor alarm shall be provided with an aluminum alloy alarm gong at least 5 inches in diameter, energy-efficient impeller, and bearings which do not require lubrication. A Y-strainer shall be installed in the alarm pipeline. The alarm shall be initiated by flow from the alarm check valve retarding chamber, dry-pipe valve, or deluge valve as required.

Electric water flow alarms shall be outdoor alarm bell type, with an aluminum alloy alarm gong at least 6 inches in diameter. The alarm bell shall be weatherproof, and shall be suitable for a 120 V ac power supply. The alarm shall be initiated by flow through the alarm check valve retarding chamber, dry-pipe valve, deluge valve, or flow switch.

2.3.09 Air Compressor. The system air compressor shall be oil-less, permanently lubricated, direct drive, with filtered air inlet and safety relief valve, and suitable for pipeline mounting. System pressure and compressor capacity shall be as required or as specified by NFPA based on the volume of the system, whichever is more stringent. The compressor motor shall be suitable for the power supply. An individual compressor shall be provided for each dry pipe system.

2.3.10 Pressure Gauges. Pressure gauges shall comply with UL 393, and shall be provided with 3-1/2 inch (89 mm) to 4-1/2 inch (114 mm) diameter dial, and a dial range of 0-250 psig (0-1724 kPa gauge).

2.3.11 Emergency Break Glass Switch. Each break-glass switch for fire sprinkler system shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Square D "Type 9001K15", Cutler Hammer 10250T Series, or approved equal, with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

2.4 CONSTRUCTION.

2.4.01 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

PART 3 - EXECUTION

3.1 INSPECTION. Contractor shall field verify all existing conditions prior to designing the system.

3.2 INSTALLATION. Piping, equipment, and appurtenances furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.2.01 Sprinkler Piping and Accessories. Deviations from approved "working plans" for sprinkler piping require recalculation and approval by authority with jurisdiction. Written approval shall be obtained from Engineer prior to deviating from approved "working plans".

Approved fittings shall be used to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes. Unions shall be installed adjacent to each valve in pipes 2 inch (51 mm) and smaller. All piping shall be hidden from view in areas with finished ceilings and other areas, as indicated, unless accepted by Engineer to be exposed.

"Inspector's Test Connections" shall be installed in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

The sprinkler piping shall be installed with drains for complete system drainage. Ball drip valves shall be installed to drain piping between fire department connections and check valves, and where indicated. Route drain to outside the building unless otherwise indicated on the drawings.

The sprinkler head riser drop lengths shall be determined in the field and shall be coordinated with all ductwork, electrical conduit, piping systems, process equipment, and tanks. If the sprinkler system piping is installed before all ductwork or other building system construction is finished and if any sprinkler head risers need to be relocated to meet the code requirements, Contractor shall extend or relocate the risers and sprinkler heads at his expense.

Hanger and support spacing and locations for steel piping joined with grooved mechanical couplings shall be in accordance with the manufacturer's written instructions for rigid systems.

Metal roof decking shall not be used for the support of equipment or piping.

Pressure gauges shall be installed at each sprinkler test connection and at top of each riser. Pressure gauges shall be provided with connections not less than 1/4 inch (7 mm) and with soft metal seated globe valve arranged for draining pipe between gage and valve. Gauges shall be installed to permit removal and shall not be installed where subject to freezing.

All alarm devices shall be connected to the fire alarm, plant control, or other system as required.

When they are specified, the water motor alarm bell or electric alarm bell shall be mounted outside on an exterior wall of the building at a location suitable to Engineer so personnel in the area will notified when an alarm is sounded.

3.2.02 Sprinkler Valves. Fire sprinkler valves shall be installed with all trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the authority having jurisdiction.

Service valves shall be supervised-open, and located to control sources of water supply except from fire department connections. Provide permanently marked identification signs indicating portion of system controlled by each valve.

Alarm check valves shall be installed in the vertical position for proper direction of flow, including bypass check valve and retard chamber drain line connection.

All double-check detector assembly backflow preventers shall be installed with bypass water meter, gate valves on each side of meter, and check valve downstream from the meter.

All reduced pressure detector assembly backflow preventers shall be installed with bypass water meter, gate valves on each side of meter, and reduced pressure backflow preventer downstream from the meter.

3.3 FIELD TESTING. Field testing of the fire sprinkler systems shall conform to the requirements of NFPA 13 "System Acceptance" Chapter and to the requirements of the local Fire Department.

Engineer and a representative of the local Fire Department will witness all tests. Contractor shall arrange the testing schedule with the Fire Department and Engineer; with at least 7 days' advance notice.

Contractor shall replace piping and components that do not pass the test procedures specified, and then retest to demonstrate compliance. The procedure shall be repeated until satisfactory results are obtained at no additional cost to Owner. Three copies of test reports shall be submitted in writing to Engineer and to the Fire Department.

Test certificates shall be executed and submitted prior to final inspection and acceptance in accordance with the requirements of NFPA No. 13. Three copies of each test certificate shall be furnished to Engineer and the Fire Department.

After installation and testing of the fire suppression system, complete drawings, conforming to installation records, including location of sprinkler heads, control valves, water supply connections, and wiring diagrams shall be submitted to Engineer prior to final acceptance.

3.4 ADJUSTING. All alarm devices shall be adjusted for proper operation. All drains shall be checked for proper operation.

3.5 CLEANING. Immediately prior to the final inspection, equipment, piping and appurtenances shall be thoroughly cleaned. Dirt and debris shall be cleaned from sprinklers. Sprinklers having paint other than factory finish shall be replaced with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.6 FINAL INSPECTION AND ACCEPTANCE. A decision shall be reached during the inspection concerning the resolution of discrepancies and changes as recommended by the authorities having jurisdiction. All work determined to be the responsibility of Contractor, and included within the scope of the specifications, shall be promptly completed at no expense to Owner.

The final acceptance of the fire sprinkler system shall be made after the completion of the corrective work resulting from the final testing and inspection and after receipt of a formal letter of acceptance from the local Fire Department.

End of Section

SECTION 15310

CLEAN AGENT FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of materials, equipment, controls, wiring, and appurtenances associated with the clean agent fire suppression system as indicated herein and on the drawings.

The Work shall include furnishing all labor, materials, tools, equipment, service and supervision required to design, install, test, and place into service the fire suppression system throughout the rooms and buildings as indicated in the Contract Documents.

1.2 GENERAL.

1.2.01 Coordination. Piping, equipment, controls, wiring, and appurtenances furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the fire suppression system is compatible with all other parts of the system; that all piping, equipment, wiring, and appurtenances are appropriate for the intended function; and that all devices necessary for a properly functioning system have been provided.

Equipment and appurtenances furnished under this section shall be the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall become familiar with details of the work, shall verify dimensions in the field, and notify Engineer of any discrepancy before performing the work.

1.2.02. General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with the applicable national, state, and local codes and ordinances, laws, regulations, and National Fire Protection Association (NFPA) Standards which pertain to such work. In case of a conflict between this section and any applicable national, state, or local code, ordinance, law, regulation, or NFPA Standard, the latter shall govern.

NFPA standards to be followed shall include, but not limited to:

NFPA 2001	Clean Agent Fire Extinguishing System
NFPA 70	National Electrical Code
NFPA 72	National Fire Alarm Code

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, working plans, flow calculations, wiring and schematic diagrams, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment and appurtenances furnished, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Device tag numbers indicated on the contract drawings shall be referenced on the submittals where applicable. The submittal to Engineer shall be made after the local authorities having jurisdiction have approved the design. The data and specifications shall include, but not be limited to, the following:

Design Documents

Complete working plans and flow calculations with information as specified by NFPA Standard No 2001.

Fire Suppression Agent

Complete description of suppression agent including physical characteristics, limitations on use, handling procedures and safety precautions.

Equipment, Piping, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

ASTM specification for pipe and fittings.

Overall dimensions.

Pressure loss data

Net weight.

Control, Detection, Alarm, and Actuation System

Name of manufacturer.

Type and model.

Control panel face layout.

Sequence of Operation.

Wiring diagrams.

Power requirements.

Test Reports

Test reports indicating successful completion of tests specified herein and as specified by NFPA Standard No. 2001.

1.3.02 Operation and Maintenance Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE. All materials and work shall conform to the requirements of NFPA and Underwriters' Laboratories (UL), and shall be permanently stamped or labeled with the Listing Agency's identification.

Materials, installation, inspection, and testing of the fire suppression system shall comply with the requirements of the local authorities having jurisdiction and Owner's insurance underwriter.

Materials and equipment shall be the standard products of manufacturers regularly engaged in the production of clean agent fire extinguishing systems. All products shall be new and of the latest manufacture. Equipment shall be supported by a service organization that is, in the opinion of Engineer, reasonably convenient to the site.

The suppression system drawings and calculations shall be performed by an individual who is certified Level II or greater by The National Institute for Certification in Engineering Technologies (NICET) in the subfield of Fire Protection Engineering Technology, Special Hazards System Layout. When indicated, the work shall be supervised and the drawings signed and sealed by a registered professional engineer licensed in the state of Michigan.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The system shall cover only the interior locations of the building as herein specified; and shall be suitable for the building construction type, room temperature range, and contents. The contents and temperature range of the area to be protected shall be as indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The clean agent fire suppression system shall be designed as a single-shot, automatic-manual, total flooding system. The suppression system shall be listed as a pre-engineered system. The system shall be provided with primary suppression agent cylinders in the quantity and location as indicated on the drawings. Reserve cylinders shall be provided as indicated in the Contract Documents.

The fire extinguishing system shall provide a concentration of fire extinguishing agent to create an atmosphere that will not support combustion when discharged in the protected areas. The discharge time for halocarbon agents shall not exceed 10 seconds. The discharge time for inert gas agents shall not exceed 60 seconds. The system design shall include the capacity to automatically maintain the design concentration for a minimum of 10 minutes, or as specified by NFPA, whichever is more stringent. A suitable allowance in agent quantity shall be made for normal leakage of agent from the spaces due to agent expansion.

2.2.01 Elevation. All components of the fire suppression system shall be designed to operate at the elevation indicated in the Contract Documents.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable agents include heptafluoropropane (FM-200) as manufactured by Great Lakes Chemical Corporation, FE-13 as manufactured by DuPont Chemicals, and INERGEN as manufactured by ANSUL Fire Protection, or approved equal.

2.4 CONSTRUCTION.

2.4.01 General. Materials and equipment shall be as specified below and as shown and shall be suitable for the service intended. Materials and equipment shall satisfy the requirements of NFPA 2001. Devices and equipment used for the same or similar services shall be of the same make and type and shall be interchangeable when of the same rating.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

All anchor bolts, expansion anchors, nuts and washers shall comply with UL, FM, and NFPA requirements. Powder-driven anchor assemblies shall not be used.

2.4.03 Piping Systems. Distribution piping shall be black or galvanized steel, either ASTM A53 seamless or electric welded, Grade A or B or ASTM A-106, Grade A, B, or C. Cast-iron pipe, steel pipe conforming to ASTM A 120, or nonmetallic pipe shall not be used. Pipe shall be furnished complete with all fittings, jointing materials, supports and anchors, and other accessories required for a complete system.

2.4.04 Pipe Fittings. Pipe fittings for FM-200 and FE-13 agents shall have a minimum working pressure of 620 psi (4280 kPa). Pipe fittings for INERGEN agent shall have a minimum working pressure downstream of the pressure reducer of 1,000 psi (6900 kPa). Cast iron and Class 150 lb steel fittings shall not be used.

2.4.05 Pipe Supports. Pipe supports shall be suitable for the application, construction, and type and size of pipe involved. "C" type clamps shall not be used for larger than 1 inch (25 mm) diameter piping, and shall be provided with retaining clips. Galvanized hanger assemblies shall be used for the support of galvanized steel piping systems.

2.4.06 Storage Containers. Agent containers shall meet the requirements of NFPA 2001. Containers shall be fitted with a resilient pressure seat type forged brass valve and shall have a threaded steel anti-recoil protective cap for handling and shipment.

Storage containers and any pressurized release containers shall be equipped with pressure switches that shall initiate a supervisory signal when cylinder pressure in a container drops to 90 percent of the system working pressure. A portable direct reading beam scale shall be provided for weighing FM-200 and FE-13 containers in place by loosening cylinder clamps and disconnecting the discharge heads. It shall not be necessary to disconnect any control components. Liquid level indicators may be provided in lieu of the portable direct reading beam scale. The containers shall be arranged to allow a service aisle for cylinder removal and cylinder weighing.

Container racks shall be provided at all installations. Racks shall be designed to rigidly secure all containers in place.

2.4.07 Discharge Valve. Each cylinder shall be fitted with a pressure operated discharge valve. Each valve shall include an integral safety relief device which serves to protect cylinder against excessive internal pressure. The cylinder valve shall have a forged brass body with external connections for actuation devices. Each valve shall be provided with a removable pressure gauge or solenoid valve with gauge for pressure reading. When more than one cylinder is connected to a common manifold, a check valve shall be provided with each cylinder. Check valves that utilize "O" ring seats shall not be used as they can be dislodged during discharge.

2.4.08 Discharge Nozzles. Nozzles shall be supplied in quantities sufficient to properly cover the areas being protected in accordance with NFPA 2001. Nozzles shall be of corrosion resistant construction and shall be designed specifically for clean agent application. Nozzles shall be permanently marked as to type and orifice size.

2.4.09 Caution/Advisory Signs. The fire suppression system contractor shall provide signs as specified by NFPA 2001 and as recommended by the clean agent manufacturer. As a minimum, the following signs shall be provided:

> A caution sign on the outside of each exterior door of the protected area. Sign shall be Fike Corporation 02-3646.
>
> A manual discharge sign at the manual discharge station. Sign shall be Fike Corporation 02-3644.
>
> A flashing light sign over each exit from the protected area. Sign shall be Fike Corporation 02-3645.

2.4.10 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of a universal primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of Master Specification Section 09900, Painting.

2.4.11 Equipment Bases. Unless otherwise indicated or specified, agent cylinders shall be installed on concrete bases at least 6 inches (150 mm) high.

2.4.12 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 CONTROLS.

2.5.01 Control Panel. The clean agent system shall be provided with a single control panel that shall be capable of all functions necessary to operate the system, including detection, actuation, and any auxiliary functions specified herein or otherwise required. The control panel shall be located where indicated on the drawings, and shall be provided with the following:

NEMA 12 enclosure with a hinged and lockable door.

Integral battery standby power supply.

Rechargeable batteries and battery charger.

Audible and visual alarms.

Auxiliary contacts for:

Trouble alarm

System alarm

Pre-discharge alarm

Discharge alarm

Ventilation shutdown

Door closures

0 to 60 second field adjustable time delay.

Container disable switch.

Class A wiring of detection and release circuits.

System inhibit (abort) switch.

Parallel wired agent release modules.

The control panel will be provided with a 120 volt, 60 Hz, single phase power supply.

2.5.02 Detectors. A minimum of two detectors shall be provided in each room. One half of the detectors in the room shall be ionization type, and the remainder shall be of the rate compensation thermal type. The temperature setpoint of thermal type detectors shall be as required, unless otherwise required by application.

2.5.03 Manual Release Switch. The manual release switch shall provide a means to discharge the container, and shall bypass all abort and time delay functions, and shall activate all alarm and shutdown devices the same as if they had been activated automatically. The manual release switch shall be located at the control panel.

2.5.04 Audible and Visual Alarms. Two audible and one visual alarm shall be provided in each protected room. One audible and one visual alarm shall be provided on the exterior of the building at the entrance to each protected room. One audible shall be the horn type, and the other audible alarm shall be the siren type. The visual alarm shall be the strobe type. Alarms located on the exterior of the building shall be suitable for wet locations.

2.5.05 Emergency Break Glass Switch. Each break-glass switch for fire suppression system shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Square D "Type 9001K15", Cutler Hammer 10250T Series, or approved equal, with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

PART 3 - EXECUTION

3.1 INSPECTION. Contractor shall field verify all existing conditions prior to submitting a bid proposal.

3.2 INSTALLATION. The installation of the complete clean agent suppression system shall be performed by the system manufacturer or an approved representative of the manufacturer. The fire suppression system shall be installed by a firm having previously installed a minimum of 5 systems similar in size and scope to this project. Personnel involved in the installation of the suppression system shall be fully experienced in installing fire detection and clean agent suppression systems. The installation of the work described herein shall be performed to avoid interference with the structure and all other equipment, wiring, piping, and ductwork located in the spaces.

Piping, wiring, equipment, and appurtenances furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. The installation shall be in accordance with the NFPA 70, NFPA 72, and NFPA 2001.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

3.2.01 Wiring. The fire suppression system contractor shall be responsible for the wiring of all devices associated with the clean agent suppression system, including but not limited to, detection devices, actuation devices, and audible and visual alarms. A 120 volt single phase power supply to the suppression system control panel will be provided by others. Wiring from the control panel to any automatic door closers will be provided as indicated in the Contract Documents. Wiring from the control panel to any ventilation systems will be provided as indicated in the Contract Documents. Any automatic door closers will as indicated in the Contract Documents. Wiring shall be in accordance with NFPA 70, NFPA 72, and Master Specification Section 16050, Electrical General Requirements.

3.3 CONTROL. The clean agent suppression system shall be capable of completely automatic operation as described herein and as specified by NFPA.

Upon the activation of the first detector, the following shall occur:

An "ALARM" lamp on the control panel shall be illuminated.

An audible alarm (horn) and visual alarm (strobe) shall be energized in the protected room.

The ventilation system shall shut down.

The door closers shall be activated.

Upon the activation of any second detector, the following shall occur:

A "PRE-DISCHARGE" lamp on the control panel shall be illuminated.

An audible alarm (siren) shall be energized in the protected room.

The agent discharge time delay sequence shall be initiated.

Upon completion of the time delay sequence, the following shall occur:

The extinguishing agent shall be released from the cylinder.

A "SYSTEM DISCHARGE" lamp on the control panel shall be energized.

A visual alarm (strobe) on the exterior of the building shall be energized.

3.4 CLEANING. Immediately prior to the final inspection, equipment, piping controls, and appurtenances shall be thoroughly cleaned. Dirt and debris shall be cleaned from discharge nozzles. Nozzles having paint other than factory finish shall be replaced with new nozzles.

3.5 ACCEPTANCE TESTS.

3.5.01 Tests. The fire suppression system shall be tested for correct operation and function. The tests shall be as specified by the local fire department and the following procedures performed in accordance with NFPA 2001:

Review of mechanical components.

Review of enclosure integrity.

Review of electrical components

Functional testing.

The tests shall be supervised by a competent, factory-trained engineer or technician authorized by the manufacturer of the equipment.

3.5.02 Enclosure Integrity Test. When indicated, an enclosure integrity test shall be performed by Contractor to ensure that the required agent concentration can be maintained. Prior to performing the test, the fire suppression system contractor shall inspect the rooms to be protected, and shall advise Owner in writing of any probable areas where excessive leakage from the space may cause the test to fail. The test shall not be performed until Contractor is advised by Owner to proceed. All test instruments shall have been recently calibrated by an independent testing agency. Contractor shall be responsible for providing all materials and labor required to perform the test. The test shall be repeated until a successful test is obtained. In the event that the test fails due to excessive leakage from the space, Owner shall be advised of the areas needing repair, and Contractor will be reimbursed a predetermined sum for repeating the test.

3.5.03 Test Report. A report of test results shall be submitted prior to final inspection and acceptance. Three copies of the report shall be furnished to Engineer and the Fire Department.

3.5.04 Final Drawings. After installation and testing of the fire suppression system, complete drawings, conforming to installation records, including location of discharge nozzles, controls, and wiring diagrams shall be submitted prior to final acceptance.

3.5.05 Final Inspection. A representative of the local fire department and Engineer will make a final inspection of the Work. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that all portions of the fire suppression system functions properly. Contractor shall arrange for the final inspection with the fire department and Engineer.

3.5.06 Final Acceptance. The final acceptance of the fire suppression system as specified shall be made after the completion of the Work resulting from the final inspection and after receipt of a formal letter of acceptance from the local fire department.

Deviations from approved "working drawings" for the suppression system require recalculation and approval by authority with jurisdiction. Written approval shall be obtained from Engineer prior to deviating from approved "working plans."

3.6 OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the suppression system manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

SECTION 15360

CARBON DIOXIDE FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK. Furnish and install a complete engineered, fixed pipe, automatic total flooding low pressure carbon dioxide fire suppression system for each of the areas indicated on the Drawings.

Each system shall be specifically engineered and installed to protect the hazard. The design and engineering shall include a thorough review of the proposed rooms for anticipated air tightness. If anticipated leakage appears unreasonably high, it shall be called to the attention of the Program Manager immediately for possible corrective action.

Each system shall be designed, installed and tested in conformance with current Standards as stipulated in item 1.05 hereinafter and the requirements of local authorities having jurisdiction and Insurance Underwriters.

All piping, and equipment shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping is shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the Drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Subcontractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.2 RELATED WORK.

Division 16, Electrical

1.3 ENGINEERING SERVICES. The Subcontractor shall retain the services of a specialty subcontractor to design and install the CO2 system. The specialty subcontractor shall employ a licensed professional engineer (in the State of Michigan) specializing in the design and installation of CO2 fire suppression systems to perform the work. The engineer shall be licensed at the time the work is done. If the state issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.

All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.4 SUBMITTALS. Submit shop drawings, product data and calculations to the city of Detroit Fire Marshall for approval. Submit proof of approval to the Program Manager.

All submittals shall contain a statement that Section 01080 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual one for each party involved, and shall be included with every submittal and resubmittal.

In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Subcontractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Subcontractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4.01 Shop Drawings. Submit shop drawings under provision of Section 01080.

Submit shop drawings indicating detailed layout of system, locating each component. Include control diagrams, wiring diagrams, and written sequence of operation.

Detailed layout drawings of piping in mechanical rooms and other congested areas shall be provided. Drawings shall show the locations of piping appurtenances, specialties, and all valve banks.

1.4.02 Product Data. Submit product data under provisions of Section 01080.

Submit product data for each piece of equipment comprising the system including storage unit, control valves, control panels, nozzles, manual releases detectors, alarm bells or horns and enunciators.

1.4.03 Calculations. For local application and total flood hazards, submit design calculation derived from computer programs developed specifically for low pressure CO_2 flow calculations. Analysis shall include calculation to verify system terminal pressures, nozzle flow rate, orifice code number, piping pressure loses, component flow data, and pipe sizes considering actual and equivalent lengths of pipe and elevation changes.

1.4.04 Test Reports. Submit test reports indicating successful completion of test to the Program Manager.

1.4.05 Installation Instructions. Submit manufacturer's installation instruction under provisions of section 01080.

1.4.06 Operating and Maintenance Data.

Operating and Maintenance Manual - Submit to the Program Manager as provided in Section 01160, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

Equipment shall be identified with the Owner's Equipment Numbers and Identification as described in the specifications and as shown on the Drawings.

Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual.

Contents - Each volume shall contain the following minimum contents:

Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

Spare Parts List

Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

1.5 REFERENCE STANDARDS.

ANSI/ASME B16.3 – malleable iron threaded fittings Class 300.

ANSI/ASME B16.9 – factory made wrought steel butt welding fittings.

ANSI/ASME B31.1 – power piping.

ANSI/ASME B31.1 – pressure vessels.

ANSI/ASME Section 8 – welding and brazing qualifications.

ANSI/WAS D1.1 – Standard Welding Code.

ANSI/NFPA 12 Carbon Dioxide Extinguishing Systems.

ANSI/NFPA 70 – National Electric Code.

NFPA 72 – National Fire Alarm Code.

ASTM–A53 – pipe, steel, black and hot dipped zinc coated, welded and seamless.

ASTM-A106 – seamless carbon steel pipe for high temperature service.

FM – Factory Mutual Engineering.

NEMA – enclosures for control panels.

IRI – Industrial Risk Insurers.

UL – Underwriters Laboratory.

Codes, Ordinances, Permits and Regulations.

Comply with all the laws, ordinances, codes, rules and regulations of the State or local authorities having jurisdiction over any of the work specified herein, and apply for, and pay for, all necessary permits.

If any part of this Section conflicts with the laws and codes, call it to the Program Manager's attention prior to commencing work. If a conflict exists, follow the more strict code or law as approved by the Program Manager.

All materials and equipment where applicable shall be type listed in current edition of FM approved guide.

Requirements set forth in this Section shall be followed when in excess of the required or minimum regulations.

1.6 QUALITY ASSURANCE. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules

Inspection by the Program Manager or his representative or failure to inspect shall not relieve the Subcontractor of responsibility to provide materials and perform the work in accordance with the documents.

The piping manufacturer shall furnish an affidavit of compliance certifying that all materials used and work performed shall comply with the specified requirements. The Subcontractor shall provide copies of mill test confirming the type of material used in the various components.

The Owner and Program Manager reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Owner and Program Manager shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work.

All rotating parts of equipment shall be statically and dynamically balanced at the factory.

1.7 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner or Program Manager by the manufacturer.

All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

Instructions for the servicing and startup of equipment in long term or prolonged storage shall accompany each item.

All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.8 DESIGN CRITERIA. The system shall be designed in accordance with the requirements and recommendations of NFPA standards noted above and shall totally flood the hazard volumes with carbon dioxide. Refer to tables in NFPA 12 for design concentrations or as noted on the fire protection systems schedule. Refer to the architectural drawings to obtain dimensions pertinent to determine the volume of the rooms or spaces to be protected.

The system shall be designed to operate automatically or by manual operation. The release of the agent shall be by an electrical signal from the control panel to the solenoid operated releasing devices.

System design shall provide for fire protection of the local application and/or total flooding type with low pressure CO2 and it covers a purging system utilizing the same low pressure CO2 to suppress or prevent fire. The system shall be fixed installation where equipment is designed and installed to provide fire suppression capability for hazards which most likely be in the form of electric heat buildup that will result in fire or explosion conditions. Total flooding shall be done with a calculated CO2 design concentration, volume of space in abnormal temperatures. All space openings shall be sealed against any air movement. Space shall be tested prior to CO2 activation test. Design, fabrication and installation of system and its components shall be in compliance with requirements and recommendations of ANSI/NFPA-12.

Interface system with plant main security room fire alarm and plant annunciation system. Signals that will be monitored shall consist of:

> Any Open Doors (greater than ½ hour) - (Trouble).
>
> Any malfunction in the Detectors/annunciation devices/CO2 local panel/CO2 tank/CO2 pressure system and any of the interposing relays in the building - (Warning).
>
> CO2 ready to discharge after a set time interval (selected by the CO2 vendor) – Alarm).
>
> CO2 activation and Discharge - (Alarm with horn).
>
> Individual alarms shall be included also in the building local panel to provide a

warning alarm during a time delay period prior to the automatic discharge of carbon dioxide. Refer to the system design in Part -2.

Refer to the electrical drawings to determine Class I, Divisions I and II, Hazard Classification of each room or space. Provide all system components to comply and be suitable for use with the hazard classification.

1.9 PERFORMANCE REQUIREMENTS.

1.9.01 Activation.

Electric: An alarm condition from any detector or operation of a manual release station (electric) shall start the pre-discharge sequence. At this time the control panel shall activate begin the pre-discharge timer(s), start all audible and visual alarm devices, shutdown exhaust air handling fans, close all dampers, release door holders, shutdown fuel and power to process equipment (if any exist inside the space) and actuate the building fire alarm system. The pre-discharge period shall be of sufficient duration for personnel to evacuate the area. The alarm devices shall continue to operate until the control panel is reset.

Pneumatic: A pneumatic time delay and pneumatic sirens are required for all total flood hazards that are normally occupied. Further, a pneumatic time delay and pneumatic sirens are required for local application systems which serve normally occupied enclosures where the discharge will expose personnel to hazardous concentrations of CO_2. The pneumatic siren(s) shall sound during the evacuation and discharge period.

Mechanical: Each master/selector valve shall be provided with an emergency manual override operator.

1.9.02 Volume. The volume of carbon dioxide for the specified concentrations shall be determined using inside area dimensions. The volume of the room space displaced by the equipment shall not be considered to reduce the requirement of carbon dioxide.

1.9.03 Tank Supervisory Alarms. System control power failure, refrigeration motor power failure and refrigeration alarm power failure shall produce a "trouble" alarm and shall be enunciated at the system control panel.

- and/or -

A refrigeration "high-low" pressure signal shall be activated by a pressure operated switch at the storage tank.

PART 2 - PRODUCTS

2.1 MATERIALS. All materials and equipment shall be new and shall be FM approved or UL listed.

2.2 MANUFACTURERS. Systems shall be as designed and manufactured by:

Kidde Fenwal Inc.

The Ansul Co.

Fire Systems Division of Chemetron Corp.

2.3 SYSTEM COMPONENTS.

2.3.01 Pipe and Piping Specifications. The following specifications set forth minimum standards for installation. If the requirements of local codes or the authority having jurisdiction are more stringent these more stringent requirement shall govern the installation.

2.3.02 Type of pipe.

Piping shall be black or galvanized ASTM grade A53 seamless or Electric welded grade A or B or A106 grade A, B or C.

Installation shall be performed in workmanlike manner according to the highest standards of modern practice.

All pipe and fittings shall be new and of recent manufacture.

All pipes shall be reamed after cutting so that all burrs and sharp edges are removed.

All pipes must be thoroughly cleaned before installation. A wire flue brush should be pulled through the length several times followed by clean cloth rags treated for the purpose. All foreign matter and oil must be removed by this process.

All pipes and fittings installed out of doors or in corrosive areas must be galvanized or treated with a proper protective coating.

Pipe Dope: All screwed pipe shall be coated with Teflon tape or an approved pipe joint compound. When tape or pipe joint compound is used coating of the threads must start at least two threads back from the pipe end.

Welding:

All welding must be performed by a certified welder.

All welded pipe 3/4" and smaller shall be welded using a gas welding or other approved method.

All welds shall be pounded to loosen scale and weld beads and then cleaned of the same.

No backing ring chill rings are permitted.

Welded Pipe Reductions: Reductions in welded pipe shall be by one of the following devices.

Butt weld concentric reducers.

Swaged nipples.

Weld o-lets

Where socket weld fittings are permitted see below, a socket weld reducing coupling can be used only for a one size reduction. All other reductions in socket weld pipe shall be made using the above permitted methods.

When methods B, C, or D are used, it is imperative that these fittings be installed in strict accordance with the manufacturer's installation instructions, in each case they must be installed so as to permit full flow. All entrance holes from the main pipe run to the fitting must be of proper size and free of sharp edges, ridges or burrs.

Threaded Pipe Reductions: Reduction in screwed pipe shall be by means of screwed concentric reducing fittings or swaged nipples. Flush bushings shall not be used. Hex bushings, 3000 lb. forged steel may be used for reduction in one pipe size only.

Flanges and Unions:

No unions over 2" size are permitted.

All flanges must be 300 pounds. ANSI class forged steel.

All weld neck flanges used with schedule 80 pipe must have extra heavy pipe wall bore schedule 80. All weld neck flanges used with schedule 40 pipe must have standard weight pipe wall bore schedule 40.

Where flanged pipe connections are used, they shall be gasketed with 1/16" thick compressed type gasket materials.

High grade steel bolts grade 8 or studs with graded nuts shall be used on all flanged connections. All nuts shall have full engagement on the bolt or stud. Use grade 8 or better.

All connectors, that is, bolts, and nuts shall be torqued to the required number or foot pounds as recommended in the standard piping handbooks. Required torque valves for installation of flanged pressure operated valves shall be the same as the Preferred CO2 Systems installed for the Chlor/Dechlor building of the GLWA WRRF.

Pipe take-Offs: All pipe take offs shall be from the side or bottom of the header. Where a take off involves a reduction of several pipe sizes, a bottom take off should be provided.

2.3.03 Tank Header. The tank header is under continuous pressure and therefore it shall be constructed of schedule 80 black steel pipe with extra heavy welding fittings and ANSI 300 pound class flanges.

The tank header can be fabricated using one of the following procedures or by a combination of these procedures.

By the use of extra heavy butt welding fittings.

By the use of extra heavy weld o-lets or thread-o-lets or equivalent.

All welds must allow full flow. No miter weld fittings shall be used. Backing rings, chill rings shall not be used.

2.3.04 Actuation Line. All piping shall be either1/2", threaded steel pipe or stainless steel tubing.

When pipe is used, the following applies:

The pipe shall be a minimum of schedule 40 and where it is installed outdoors or other corrosive environments, galvanized pipe shall be used. (Industrial Risk Insurers requires all piping to be schedule 40 galvanized or schedule 80 black.)

All threaded pipe connections shall be treated with a suitable pipe sealant (i.e., Swak by Cajun Part No. MS PTS-50: Rector seal or equivalent is acceptable). The use of Teflon tape on actuation line piping is not allowed.

All pipe fittings shall be 300 lb. malleable or ductile iron. A 300 lb. steel union shall be installed near the termination of all piping. The use of 150 lb. fittings is not allowed.

Whenever tubing is used, the following applies:

All steel tubing shall be 1/2" X .035 wall and shall be painted to provide corrosion protection. All tubing installed outdoors or in corrosive atmosphere shall be stainless steel 1/2" X .035.

All tubing fittings shall be of the same material as the tubing and shall be of the compression type. All tubing to pipe fittings shall be treated with a pipe sealant as described in 2.B above.

All tubing shall be properly supported.

A filter supplied by CO2 equipment supplier shall be installed at the actuation line termination into each valve, (as shown on design drawings).

Whenever a hose reel bleeder valve is used, a 1/4" pressure regulator may be installed directly on top of the sub-header piping upstream of the selector valve or bleeder. The location of these regulators shall be as shown on the system design drawings.

The actuation line shall be provided with an approved pressure regulator to maintain 100 PSI pressure on the actuation line.

The actuation line shall be provided with an approved two level supervisory switch to provide notification at the control panel when pressure in the actuation line drops to 90 PSI and 80 PSI respectively.

2.3.05 Master Valve Piping. All piping downstream of master valve between master valve and selector valves or between valve and hose reels shall be either

Schedule 40 black steel pipe welded with welded fittings, or,

Schedule 40 steel pipe with listed grooved type couplings and fittings.

When method (A) is used, the following can be used.

Standard weight socket weld fittings are acceptable with exception that no reducing coupling can be used only for a one size reduction. All other reductions shall be made using a butt welding concentric reducer.

Standard weight butt-welding fittings. Backing rings, (chill rings) shall not be used.

1000 pound forged steel screwed fittings, back welded.

When method (B) is used, the following applies:

Where grooved couplings and fittings are used, they shall be listed/approved for use with low pressure carbon dioxide fire systems.

Pipe preparation must be in strict accordance with the manufacturers recommended procedure. Installation must be exactly as per the manufacturing specifications in all aspects.

Grooved couplings shall be installed so as the allow contraction of the pipe (pipe ends butted together).

Grooved couplings must be approved in advance by the system designer with approval obtained prior to start of design.

2.3.06 Discharge Piping. Piping downstream of selector valves, that is piping which is open to atmosphere, shall be schedule 40. Screwed pipe joints are always permitted and in most installations, approved grooved pipe connections may be used. Grooved fittings must be approved for use with carbon dioxide. Approval of fittings must be sought prior to the start of installation.

Screwed Joints: Threaded pipe fittings shall be class 300 pound malleable iron or ductile iron for pipe through 3" 1000 pound ductile iron forged steel shall be used in all larger sizes.

Grooved Joints:

Where grooved couplings and fittings are used, they shall be listed/approved for use with low pressure carbon dioxide fire systems.

Pipe preparation must be in strict accordance with the manufacturer's recommended procedure. Installation must be exactly as per the manufacturer's specification in all respects.

Grooved couplings shall be installed so as to allow contraction of the pipe (pipe ends butted together).

2.3.07 Pressure Relief Piping and Fittings. Piping to pressure reliefs shall be as specified above for discharge piping. All takeoffs for pressure relief piping shall be from the top of the discharge piping.

2.3.08 Dirt Trap. A dirt trap consisting of a tee with capped nipple shall be installed at the end of each run. The nipple shall be at least 2" long. A longer nipple up to approximately 18" is preferred where space permits.

Note: Dirt traps for schedule 40 welded headers are to be formed by welding a schedule 80 nipple to the end of the line. The schedule 80 nipple is threaded at the open end for connection of a screwed pipe cap.

2.3.09 Underground Piping. Underground piping is to be avoided - if unavoidable, a piping configuration layout for underground piping should be submitted, a layout for underground piping should be submitted for approval to system designer prior to the start of system design. The following general requirements shall apply to underground piping:

Trench depth for underground piping shall be a minimum of 3 feet or below frost line whichever is deeper.

Underground pipe shall be schedule 80 black steel with welded joints as specified for the type of run involved.

A protective, insulate covering will be required of all underground pipe. Approval of system designer is required.

Underground piping shall be welded when possible. The only exception would be in a hazardous location where welding is not permitted. In this case, flanged connection shall be used. All underground pipe joints shall be tested for leaks at 300 PSI before the insulation and protective coating is applied.

2.3.10 Pipe Sleeves. All piping through building walls, partitions, floors slabs, roof slabs and the like, shall be sleeved.

Sleeves shall be schedule 40 pipe at least two sizes larger that the pipe being sleeved. One inch pipe is the minimum size to be used as a sleeve.

Sleeves shall be packed with an approved sealing material so as to be dust light.

Sleeves through floor slabs must extend at least 2 above the floor. A greater extension may be used if required by local building codes.

Sleeves extending through roof slabs must extend above the roof and be flashed in accordance with local building codes.

2.3.11 Expansion Joints. Contraction of steel piping during discharge is based on 1" of contraction per 100 feet of steel pipe.

Allowance must be made for this contraction by using either a joint which permits movement, a piping system which contains natural swing joints, fabricated circular type "U" type bends or, in cases where space is limited, an approved manufactured expansion joint.

In piping which utilized grooved type couplings, these couplings shall be installed to permit contraction of the piping.

In straight runs using welded or screwed joints, an expansion joint must be installed within approximately 100 feet of continuous run and each approximate 100 feet of run thereafter. For runs using grooved pipe, a representative of the manufacturer should be contacted to determine the location and number of expansion joints in long runs.

Pipe anchors shall be capable of with standing any contraction thrusts that may be imposed by the piping while permitting movement intended in the design of the piping system to relieve stress. This will required rigid anchoring of certain points in the piping system while leaving other points of the pipe free to move longitudinally so as to relieve stress.

2.3.12 Inspection for Mechanical Integrity. All testing and inspections shall be done in the presence and under the supervision of the equipment manufacturer's test representative.

All pipe and fittings that are under constant tank pressure ball shall be bubble tight. Bubble tests shall be made using leak-tec, or approved equal, under full tank pressure.

Concealed pipe joints such as those in walls, ceilings, trenches and the like shall be tested at 300 PSI before the joint is concealed.

Pipelines not under constant pressure shall not exhibit any visible or audible leak, but bubble tightness is generally not required.

Under no conditions shall water be used to test piping or other CO2 equipment. Either dry nitrogen or CO2 shall be used for testing.

2.3.13 Painting. nPainting requirements shall be similar to the painting used for the Chlorination/De-chlorination buildings of GLWA WRRF and shall be of the moisture resistant/proof type and suitable for indoor and outdoor use.

2.3.14 Pipe Hangers and Supports. All pipe hangers and supports shall conform to the provisions outlined in ANSI B31.1, latest edition, except as modified and supplemented by this specification. All pipes must be solidly anchored to structural members where longitudinal or lateral movement is possible.

Rigid hangers are required wherever a change of direction or a change in the elevation of the piping system occurs. For long straight runs and as a minimum, every other hanger shall be rigid. All hangers shall be fabricated of steel and installed in a workmanlike manner.

All piping shall be attached to rigid hangers by means of u-bolts locked double nuts. The pipe shall be free to move longitudinally within the u-bolt except where the piping design requires it to be anchored.

Hangers and pipe shall be designed to prevent stress from being induced into piping during the temperature change caused by a system discharge.

All piping supports shall be fabricated and installed so that they will not be disengaged by the movement of supported pipe

Pipe shall not be hung using one pipeline as a support for another.

Piping supports shall be arranged so that no excessive bending stresses are induced into the piping from concentrated loads between supports.

The maximum spacing between pipe supports for screwed or welded pipes is given in table 1 below:

Table #1
Maximum Spacing between Supports for Screwed or Welding Pipe:

Nominal Pipe Size (Inches)	Maximum Span (Feet)
1/4	5
1/2	5
3/4	6
1	7
1 1/4	8
1 1/2	9
2	10
2 1/2	11
3	12
4	14
5	16
6	17
8	19

Maximum spacing between pipe supports is given in table 2 below for systems utilizing the grooved coupling method for system discharge piping.

Table #2
Minimum Spacing between Supports for Pipe with Grooved Joints:

Nominal Pipe Size (Inches)	Maximum Span (Feet)
3/4	7
1	7
1 1/4	7
2	7
3	10
4	10
5	12
6	12

2.4 Carbon Dioxide System Component Requirements. The components of the carbon dioxide systems shall be provided in accordance with the following requirements.

2.4.01 Storage Unit. The storage tank shall be built to ASME standards, and bear the ASME label. It shall be installed for all the electrical buildings specified under item 1.01A with flexible hoses to the CO2 piping system to provide flexibility of movement and protect for any unexpected differential settlement of the concrete pad which may exceed 1.5”. The installation of such hoses shall meet the requirements of NFPA 12.

The storage tank is to have a baked white aluminum housing to protect the insulation and should be riveted and sealed at all joints, to prevent water damage to the insulation.

The storage tank shall be supported by two saddles of heavy steel construction welded and cross braced to the vessel for adequate support.

The storage vessel shall be provided with two top lifting lugs.

Tank pressure gauge shall be 6 inch dial type with a rated accuracy of 1/2 of 1%.

The tank liquid level gauge shall read contents in thousand of pounds of liquid CO2 at 0 degrees Fahrenheit. The gauge divisions shall be in two hundred pound increments.

The liquid level gauge shall be equipped with one set of electrical contacts which may be used to enunciate a low liquid level in the storage unit.

The storage unit shall be equipped with two independent alarm pressure switches for annunciation of high or low tank pressure. These switches shall operate at 315

PSIG and 250 PSIG respectively.

The storage unit shall be equipped with the required ASME safety relief. This relief shall be set at 350 PSIG.

A high pressure bleeder valve set at 330 PSIG shall be included with the storage unit assembly.

•The refrigeration system shall operate on a power supply of 208 or 460 volts, 60Hz. For the power service to the refrigeration system, a disconnect switch shall be provided by the CO2 vendor and shall be installed by the electrical contractor.

2.4.02 Valves. All valves shall meet the requirements set forth in the current edition of the NFPA Standard 12, and shall be F.M. approved for carbon dioxide extinguishing systems.

Tank Shut-Off Valves

A manually operated tank shut-off valve shall be provided. Valves are sized 3" through 8" and shall be equipped with a geared hand wheel operator and carry a 300 pound rating. The flanges mounted either side of the valve must have inside diameter chamfered 1/4" deep 45 degree angle for the valve clearance.

The tank shut-off valve shall be equipped with a DPDT limit switch to permit remote annunciation if the valve is other than fully opened. The contacts shall be provided on the tank shut-off valve to indicate fully closed position.

Master/Selector Valves

Valves in sizes 1/2" to and including 2" shall be ball type approved for low pressure carbon dioxide service. Valves in sizes 3" and larger shall be high performance butterfly style suitable for low pressure carbon dioxide service.

The master valve and selector valve shall not fail open. The master or selector valve shall not open automatically in the event of any electric or pneumatic failure.

Master/selector valves shall be provided with spring return pneumatic actuators. An override device shall be mounted on the valve actuator or within the Automatic Time Delay Cabinet for emergency manual operation.

Isolation Valves

Valves in sizes 1/2" to and including 2" shall be ball type approved for low pressure carbon dioxide service. Valves in sizes 3" and larger shall be high performance butterfly style suitable for low pressure carbon dioxide service.

The isolation valve shall be fitted with an electrical status switch.

The isolation valve shall have device to accommodate a lock.

2.4.03 Actuation Line Supervision. Actuation line serving all master/selector valves shall be supervised.

Actuation line to be provided with a supervisory pressure switch to provide annunciation at 80 PSI.

Actuation line to be provided with a pressure regulator to maintain 100 PSI on the line.

2.4.04 Nozzles. Nozzles shall be supplied in quantities sufficient to properly cover the areas being protected in accordance with NFPA-12.

Nozzles shall be permanently marked as to type and orifice.

2.4.05 Electrical. The electric service to the storage tank shall be provided with a fused disconnect supplied by the CO2 vendor and sized per the electrical requirements of the tank compressor.

CO2 System Control Panel and electrical devices shall be designed to operate on 24 VDC service.

All field electrical devices shall be supervised for electrical integrity.

All master/selector valve solenoid circuits shall incorporate maintenance lock-out switch to disable the solenoid during maintenance.

2.4.06 Control Panel. Provide an AUTOPULSE IQ-636X control panel or equivalent and to be located as shown on the drawings to electrically activate the carbon dioxide system. The control panel shall be modular and serve as many zones as required.

The control panel shall be FM approved for fire alarm and releasing service.

The control panel shall provide visual indication on the panel face for the following:

Each initiating circuit alarm and circuit trouble.

Each carbon dioxide release circuit alarm and circuit trouble.

Primary power source failure for each zone.

The control panel shall operate on the single zone concept. Any single activated detector shall be processed by the control panel as an alarm condition. The discharge circuit shall be energized in the affected area and the red "Release" LED on the panel will illuminate.

Alarm, trouble and AC power failure output contacts for each zone shall actuate the local alarm and common building fire alarm system.

Provide SPDT dry contacts for the following output signals to the Building Fire alarm panel:

General alarm condition, discharge notification.

General trouble condition, operational problem notification.

Loss of primary power source to the control panel.

Discharge disabled mechanically or electrically.

Storage unit refrigeration unit power failure.

Storage tank "high-low" pressure trouble.

The control panel shall have battery backup to support the entire system for 24 hours and then perform an alarm sequence for 10 minutes in the event of a primary power failure, but in no case shall be less than 8 AH. A charger shall be provided to recover the batteries in 48 hours from a fully discharged condition. Standby batteries shall be of the sealed, gel-type or lead calcium type. Batteries shall be supervised and provided a trouble signal upon low voltage, open or shorted cell.

The control panel shall be UL listed, FM approved and comply with the requirements as set forth in NFPA 72.

The control panel shall have Class “B” parallel wiring of the all the detection circuits.

The control panel shall utilize series supervised solenoid devices as the method of discharging the extinguishing agent. The solenoids shall be energized directly from the control panel when system discharge is required. Systems which employ devices external to the control panel to either supervise releasing devices or provide energy for discharge will not be accepted.

The control panel shall be equipped with a supervised service disconnect switch. Operation of this switch shall generate a trouble signal, activate a LED and electrically isolate all releasing devices from receiving a discharge signal. With the switch in the "disconnected" position, it shall be possible to simulate any alarm condition and observe proper operation of all detection and signaling circuits without causing agent discharge.

The control panel shall be equipped with auxiliary relays for shutdown operations. The control panel shall be capable of programming relays independently to operate on either, trouble, alarm, pre discharge, or discharge modes.

The control panel, in addition to its yellow system trouble LED, shall further break down a trouble condition with the use of diagnostic LED's. These LED's shall indicate the following trouble conditions:

Open condition, pressure supervisory circuit (separate diagnostic LED).

Alarm audible circuit reverse polarity, open or short circuit.

Pre discharge/discharge audible circuit reverse polarity, short or open.

Detection circuit (separate LED for each detection circuit).

Releasing circuit open circuit.

Manual release circuit open circuit.

AC power loss.

Ground fault.

System alarm audible circuit reverse polarity, short or open.

Microprocessor failure flashing indicator.

The control panel shall have a common control board, which provides common alarm and trouble indications as well as alarm silence and reset switches. A common Class "B" wired general alarm circuit shall be provided for common area signaling as well as separate form "C" dry contacts for general alarm and trouble. A signal switch shall be provided that will silence all active signals. Silencing of audible alarms shall be controlled by "resound" logic, whereby any subsequent new alarm conditions will reactivate audible circuits. A "lamp test" switch shall be provided which will illuminate all alarm and diagnostic LED's.

Control panel shall have a solid state, high speed switching power supply with 24 VDC output capable of responding instantly to voltage and current surges on the input and output sides to protect the system from malfunction and damage. A supervised battery charging circuit and ground fault sensing circuitry shall be an integral part of the power supply. Battery standby power shall be "on line" such that batteries will supply power to the system in the event of AC power loss without a power transfer relay.

One board shall be provided for each protected area. The unit shall provide Class "A" wired detection and series supervised release circuits, Class "B", different distinct audible and visual indications for alarm, pre- discharge, and discharge conditions. Supervised manual release circuits shall be provided.

Each control panel shall have alarm output contacts (dry) for "system operation" and "system trouble," that shall:

Be direct hard wired into the HVAC control systems serving the building ventilation shut them down in the event of an alarm.

Be connected to the plant process control system to alert the operators of a problem.

See paragraph 3.03B below.

2.4.07 Alarm Devices. Electrically actuated fire alarm horns and strobe lights shall be furnished and installed. Each fire alarm horn strobe shall be actuated and receive operating power from the control panel. Terminals for this purpose shall be provided in the system control cabinet. Each device shall be approved or listed.

The contractor shall furnish and install adequate fire alarm horns and strobes (orange color) to notify plant personnel located in the protected areas. Additionally, horn/strobes shall be provided outside the entrance(s) to the protected area. The output for the audible and visible devices shall be adequate for the conditions encountered.

2.4.08 Thermal Detectors. Compact, stainless steel cover, hermetically sealed assembly, rate of rise compensating type. The setting shall be in accordance with NFPA 72E recommendations.

2.4.09 Manual Release Stations. The Manual release stations shall be located at major points of egress and as shown on Drawings. The manual release station shall provide a means of manually discharging the automatic fire extinguishing system when used in conjunction with the control panel. The manual release switch shall be the "dual action" type, to prevent accidental operation. The switch shall remain in the operated position until reset.

2.4.10 Tank Final Inspection and Test. After all live testing is done on an area or an electrical room, the tank/s shall be recharged when done at the contractor's/vendor's expense before sign off.

2.5 SYSTEM DESIGN TOTAL FLOODING SYSTEMS. Design of the carbon dioxide system shall be based upon the enclosure being sufficiently tight against agent leakage with all ventilation automatically shut down and/or fire dampers to provide for static air condition upon discharge, or shall be appropriately designed to compensate for openings that cannot be closed. Refer to Paragraph 1.01B above.

All appropriate doors, windows, vents and dampers shall be automatically closed before discharge of carbon dioxide. Devices for this purpose shall include pressure operated trips or switches where appropriate.

Agent quantity calculations shall be determined from dimensions furnished on contract drawings for a design concentration percentage at a minimum anticipated hazard temperature.

Pre discharge alarms and mechanical discharge delays shall be provided. They shall be of sufficient duration to warn personnel of an impending discharge of carbon dioxide and allow for hazard area evacuation and preparation.

Electronic Time (discharge) delays will not be permitted or acceptable.

Warning signs shall be provided at each entrance doors to the buildings. The warning signs shall be 18" high by 30" wide with a baked enamel finish. Lettering shall warn the personnel of the presence of a CO2 fire suppression system.

The minimum discharge period shall be within 1 minute. The discharge period shall be lengthened as appropriate by considerations such as deep seated type fires.

Discharge nozzles, detectors and auxiliary equipment shall be located so as not to interfere with the hazard operation and/or maintenance.

PART 3 - EXECUTION

3.1 INSTALLATION. The Subcontractor shall not install any equipment or materials until the Program Manager and DESIGN SUBCONSULTANT had approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Subcontractor's risk.

Provide all labor and material required to set up, mount and connect all system equipment in accordance with NFPA standards. The system shall be installed in strict accordance with the manufacturer's recommendations.

All piping and fittings shall be thoroughly cleaned as assembled. All welded joints to be pounded to loosen scale and weld beads and then use the following procedure. Pull wire flue brush through each length several times. Pull clean cloth rags (not burlap or similar) treated with carbon tetrachloride, or a solution of 50 percent carbon tetrachloride and 50 percent Stoddard's solvent through each pipe length.

The system shall be wired in accordance with the manufacturers diagrams and requirements and the regulations of the Detroit Fire Department. All wiring shall be installed in conduit.

All wiring shall be in accordance with the NEC and local codes, the NFPA Standards No. 72, 72E, 72G, 72H, or the local authority having jurisdiction.

The Subcontractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

3.2 <u>INSTRUCTIONS</u>. The system shall include permanent nameplates and instruction plates to identify the system and instruct its use under emergency conditions. In addition, provide three copies of an operation and maintenance manual which shall include system mechanical and electrical drawings, a written description of the system design and operation referenced to the system drawings, technical bulletins describing each piece of equipment in the system and inspection and maintenance directions.

3.3 <u>SEQUENCE OF OPERATION</u>. The system shall be designed and installed such that it is actuated by any one of the detectors located in the substation rooms.

Actuation of any detector or manual station shall:

> Provide steady alarm electronic sounder signal associated with the area in which the detector was actuated.
>
> Annunciate to Owner's monitoring equipment at the plant central security room.
>
> Perform necessary control functions such as HVAC equipment shutdown and dampers closure.
>
> Shut down and/or keep all emergency generators from starting.
>
> Close all doors leading into protected area.
>
> Discharge agent.

The system shall be capable of being actuated by manual discharge switches for each protected area. Operation of a manual discharge switch shall cause alarm and shutdown devices to operate the same as if the system had operated automatically and shall cause immediate discharge after the time delay period.

Upon entering the alarm mode, audible indication shall be supplied by the steady sounding of an alarm electronic sounder. This unit shall be polarized for full supervision and UL listed. It shall have an output of 82 to 99 dBA at 24 VDC. The sounder shall be provided with a red finish. All field wiring connections shall be made to terminal strips or wire leads on the device.

3.4 ACCEPTANCE TESTS. Perform a complete approval test in the presence of the Owner's representative and governing authorities.

All test procedures shall be performed in accordance with NFPA 12, Section 1 7.3.

Tests shall demonstrate that the entire system functions as intended. All circuits shall be tested: Automatic discharge, manual discharge equipment shutdown and alarm devices. In addition, supervision of each circuit shall be tested. Each detection device shall be tested according to the manufacturer's recommended procedures and NFPA 72E.

Discharge tests shall be conducted. Tests shall be conducted with the equipment manufacturer or equipment manufacturer's representative in the presence of the Owner's representative. Such tests shall be made only after the control system has tested satisfactorily. Carbon dioxide shall be used as the test agent.

Test containers shall be filled to the designed weight. The amount of gas shall be certified by the Subcontractor.

Provide all necessary test apparatus and instrumentation including gas to be expended.

Gas analyzers capable of automatically monitoring three sampling points simultaneously shall be provided. Concentration measurements shall be recorded every 5 seconds on separate strip charts. Sampling probes shall be placed at three different heights in different sections of the protected area. In no case will a probe be placed higher than the highest anticipated combustible hazard. In large buildings, additional test points may be required. The number of points shall be determined by the Program Manager.

Correct all defects and make additional tests, at no additional cost to the Program Manager or Owner, until the system complies with all contract requirements.
Upon acceptance by the Program Manager and the authority having jurisdiction, the complete system shall be reconditioned, tanks refilled and the system placed in full

operation with proper tags.

As a condition of final acceptance, provide operational training to the Owner's personnel. The training sessions shall include emergency procedures, system control panel operation, trouble procedures and safety requirements. Refer to item 4.03 below.

A maintenance agreement shall be submitted to the Owner for consideration only.

As part of the acceptance test, the contractor shall prepare and submit all the ‘As-built” drawings, and tables to the Program Manager.

PART 4 - SPECIAL REQUIREMENTS

4.1 FACTORY TESTING AND WITNESSING. Factory testing is required on the individual devices and equipment of the complete CO2 system and as specified under this specification. All factory testing documentation and written reports shall be properly dated and made available to the owner representative on site.

At least 2 weeks before the proposed field testing for acceptance of the complete CO2 system, contractor shall notify the engineer of the expected testing date for witnessing. The contractor shall submit a report from the CO2 vendor and equipment manufacturer detailing the proposed performance testing of the system.

4.2 SPARE PARTS AND MAINTENANCE TOOLS. Spare parts, maintenance and tools shall conform to the requirements of specification Section 01180. The CO2 vendor can submit a recommended spare parts list for all equipment supplied to allow DWSD decide and select from the list and also allow the plant to enlarge list if is found necessary to do that.

4.3 TRAINING. The CO2 vendor shall provide a training program to the owner. The program shall include all timing, materials, classes and any required certification for the plant personnel to assume responsibility of maintaining the CO2 system with the help of CO2 specialists.

The CO2 contractor shall present to the owner a document outlining the procedure to incorporate the training indicated in (A) above.

4.4 WARRANTIES. The products shall be warranted against any defects in material or workmanship per Section 01180.

The manufacturer of the equipment shall describe the maintenance to be performed during the warranty period to maintain warranty conditions.
In addition to the above, the following special warranty provisions shall apply:

The Subcontractor shall obtain an extended warranty for 3 years for the equipment furnished under this specification.

The extended warranty shall cover all equipment furnished under this specification from the time it is placed into operation (which can be any time during the construction period) until one year after final acceptance.

The extended warranty can be in the form of:

A maintenance agreement that should be included in this contract shall cover any equipment installations/replacements, repair, recharging system, corrective and preventive maintenance, calibration of gauges and monitoring devices (if any installed in the system) and inspection and testing. In addition to that, the agreement shall allow DWSD to get specs, PMs, and equipment info into their CMMS and get DWSD personnel trained to all of that. In addition to above, the agreement can include an O&M contract in place with the right training, certifications, and licensing to do all of this as recommended by the CO2 supplier.

End of Section

SECTION 15400

PLUMBING

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated in the Contract Documents. Additional requirements for plumbing systems shall be as indicated in the schedules on the drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as specified in the schedules. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All plumbing equipment, piping, and valves denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Metal nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-

1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Plumbing equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080 Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Horsepower (kW).

Power requirements.

Net weight.

Wiring diagrams.

Plumbing Fixtures

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Water consumption data.

Overall dimensions.

Rough-in dimensions.

Piping connection sizes and locations.

Net weight.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated in the Contract Documents.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Qualification. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

1.5.03 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5.04 Construction. Plumbing fixtures shall be constructed in accordance with the following standards:

Enameled Cast Iron	ANSI/ASME A112.19.1M
Vitreous China	ANSI/ASME A112.19.2M
Stainless Steel	ANSI/ASME A112.19.3M

Enameled Steel	ANSI/ASME A112.19.4M
Emergency/Safety Fixtures	ANSI Z358.1

Electric water coolers shall be UL listed and certified in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 1010. All materials in contact with water shall comply with the Safe Drinking Water Act of 1986, and the Lead Contamination Control Act of 1988.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.7 EXTRA MATERIALS. Extra materials shall be furnished for each type and size of plumbing fixture or equipment as indicated in the Contract Documents, in the quantities indicated below.

Part	Number Required
Flushometer valve repair kits	1 per 5 fixtures
Tank type water closet ballcocks, flush valves, and floats	1 per 5 fixtures
Water closet seats	1 per 10 fixtures
Faucet washer and O-ring kits	1 per 5 fixtures
Faucet cartridge and O-ring kits	1 per 5 fixtures
Electric water heater elements	1 per heater
Water heater relief valves	1 per heater

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the drawings.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated on the drawings.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

2.4.02 Surface Preparation. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.03 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of Master Specification Section 09900, Painting.

2.4.04 Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.05 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.06 Piping Systems. Unless otherwise specified herein, piping system materials shall conform to Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies and Master Specification Section 15061, Ductile Iron Pipe.

2.4.07 Valves. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall conform to the Master Specification Section 15100, Miscellaneous Valves and Master Specification Section 15104, Resilient-Seated Gate Valves.

2.5 WATER SUPPLY PIPING ACCESSORIES.

2.5.01 Water Hammer Arrestors. Water hammer arrestors shall be either bellows or piston type. Bellows type arrestors shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arrestors shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arrestors shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arrestors shall be rated for a maximum working pressure of 350 psig (2400 kPa gauge) and a temperature range of 33° F to 250° F (1° C to 120° C). Water hammer arrestors shall be Smith "Hydrotrol", Josam "75000 Series Absorbotron", Wade "Shokstop", Sioux Chief "Hydra-Rester", or approved equal.

2.5.02 Trap Primers. Trap primer valves shall be flow activated, pressure activated, or tailpiece type as indicated in the Contract Documents.

2.5.02.01 Flow Activated Trap Primers. Flow activated trap primer valves shall be the automatic type activated by water flow in a pipeline. The primer valve shall consist of a bronze body with removable operating parts, an integral vacuum breaker, and a gasketed access cover. Connections shall be 1/2 inch (13 mm) NPT. Trap primer valves shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1018. Trap primer valves shall be Smith "2699", Josam "Series 88250", Wade "W-2400", or approved equal.

2.5.02.02 Pressure Activated Trap Primers. Pressure activated trap primer valves shall be the automatic type activated by pressure drop in a pipeline. The primer valve shall consist of a brass body with removable operating parts and an integral air gap. A distribution unit shall be provided when a single primer valve serves multiple traps. The trap primer shall be self-adjusting to line pressure and shall not require field adjustment. Connections shall be 1/2 inch (13 mm) NPT. Trap primer valves shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1018. Trap primer valves shall be Precision Plumbing Products "Prime-Rite PR-500", or approved equal.

2.5.02.03 Tailpiece Trap Primers. Trap primers installed in a flush valve water closet supply or lavatory drain shall consist of a chrome plated brass plumbing fixture tailpiece with a 1/2 inch (13 mm) OD diverter pipe and compression connection for copper tubing.

2.5.02.04 Thermostatic Mixing Valves. Thermostatic mixing valves shall comply with ASSE 1017, shall be bronze or brass body, with stainless steel flow control components, threaded end connections, rotating handle adjustment, lockable setpoint, and hot and cold check stops. Valves shall be suitable for flow ranges and have temperature adjustment ranges as indicated in the schedules. Accuracy shall within 3° F (2° C) of setpoint. Thermostatic mixing valves shall be manufactured by Symmons, Leonard, Powers, or approved equal.

2.6 DRAINAGE AND VENT PIPING ACCESSORIES.

2.6.01 Cleanouts. Cleanouts shall be provided where indicated on the drawings and required by the referenced codes.

Floor cleanouts shall consist of a two piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanouts shall be stainless steel or nickel bronze, as indicated. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.

Cast iron cleanouts shall be manufactured by Smith, Josam, Wade, or approved equal. Polypropylene cleanouts shall be manufactured by Orion, Enfield, or approved equal. PVC cleanouts shall be manufactured by Sioux Chief, or approved equal.

2.6.02 Bell-Up Drains. Unless otherwise indicated, bell-up drains shall consist of a drainage pipe hub extended to 1 inch (25 mm) above the finished floor. For chemical-resistant waste systems, bell-up drains shall consist of a plain end section of pipe, with a coupling extended 1 inch (25 mm) above the finished floor.

2.6.03 Funnel Receptors. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch (25 mm) above the finished floor.

Funnel receptors shall be Smith “Series 3800”, Josam, Wade, or approved equal.

2.6.04 Floor Drains. Floor drains shall be of the types specified herein and indicated on the drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.

Cast-iron floor drains shall be manufactured by Smith, Josam, Wade, or approved equal. Polypropylene floor drains shall be manufactured by Orion, Enfield, or approved equal. PVC loor drains shall be manufactured by Sioux Chief, or approved equal.

2.6.05 Roof Drains and Overflow Roof Drains. Roof drains and overflow roof drains shall be of the types specified herein and indicated on the drawings. Roof drains shall consist of a cast iron dome, a cast iron body, a sump receiver, an integral flange, and an extension for insulation thickness, where applicable. Drains for aggregate-surfaced roofing shall be provided with gravel stops. For other than cast-in-place locations, roof drains shall be provided with underdeck clamps. When indicated on the drawings, overflow roof drains shall be provided with interior extension rings. Roof drains and overflow roof drains shall be manufactured by Smith, Josam, Wade, or approved equal.

2.6.06 Downspout Nozzles. Downspout nozzles shall be cast brass or bronze, and shall be provided with a threaded inlet and a mounting flange. The mounting flange shall be provided with drilled fastening lugs. Downspout nozzles shall be Smith

"Model 1770", Josam, Wade, or approved equal.

2.6.07 Modular Trench Drain System. Modular trench drain systems shall be of the types specified herein and indicated on the drawings. The modular trench drain system shall include pre-sloped channel drain sections, end caps, outlet connections, grating, and all other components and accessories required for a complete installation. Drainage channels and related components shall be constructed of corrosion resistant polymer concrete. The grating shall be suitable for extra heavy traffic. The modular trench drain system shall be manufactured by Smith ACO, ABT Polydrain, or approved equal.

2.6.08 Floor Sinks. Floor sinks shall consist of a cast iron body with acid resistant interior finish, and a nickel-bronze grate. The grate shall be of the type indicated on the drawings shall be easily removable for cleaning. Floor sink grates and outlets shall be sized as indicated on the drawings. Floor sinks shall be manufactured by Smith, Josam, Wade, or approved equal.

2.6.09 Backwater Valves. Backwater valves shall be of the types as specified herein and indicated on the drawings. In-line backwater valves shall be provided with a hinged flapper valve and a bolted top access cover or a knife gate valve as indicated on the drawings. Knife gate valves shall be provided with a bronze gate and removable wheel handle. When indicated on the drawings, the access cover or handwheel operator shall be extended to finish floor or grade.

Terminal backwater valves shall be provided with a hinged flapper valve and an inlet hub connection. The flapper valve shall be factory set to be fully closed in the normal position.

Ball-float backwater valves shall be provided with cast-iron body, removable bronze seat ring, neoprene seat and ball-float. Ball float backwater valves shall be provided with threaded inlet connection and threaded or no-hub outlet connection as appropriate for the piping system.

Cast-iron backwater valves shall be manufactured by Smith, Josam, Wade, or approved equal. PVC backwater valves shall be manufactured by NDS, Plastic Oddities, Inc, or approved equal.

2.6.10 Vent Flashings. Plumbing vent flashings shall be furnished and installed as indicated on the drawings.

2.7 PLUMBING FIXTURES AND ACCESSORIES.

2.7.01 General. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.

2.7.02 Water Closets. Water closets shall be of vitreous china, with an elongated bowl and siphon jet flushing action. The type and water use of water closets shall be as indicated on the drawings. All water closets shall be provided with anchor bolt caps. Flush valve type water closets shall be provided with top spud connections for flushometer valves. Flush tank type water closets shall be provided with factory installed tank liners. Field installed liner kits will not be acceptable. Water closets shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.02.01 Seats. Water closet seats shall be white, solid plastic, contoured, elongated open front type without cover, with concealed check and stainless steel hinges. The seats shall be manufactured by Kohler, American Standard, Eljer, Church, or approved equal.

2.7.02.02 Flush Valves. Flush valves for top spud type water closets shall be exposed type, with a chrome plated brass body, an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 1 inch (25 mm) NPT water supply connection. Flush valves shall be Sloan "Royal" Delaney, or approved equal.

2.7.02.03 Supply Set. A supply set consisting of a 1/2 inch (13 mm) NPT brass angle loose key stop valve, a copper supply tube, and an escutcheon plate shall be furnished for each tank type water closet. All supply components shall be polished chrome.

2.7.02.04 Chair Carriers. Wall-mounted water closets shall be provided with adjustable chair carriers. The carriers shall be suitable for the chase depth and piping arrangement and shall consist of a heavy-duty cast iron body, complete with a drainage fitting, pylon feet, a drainage nipple, fitting and fixture gaskets, a positioning frame or template, and mounting hardware. Chair carriers shall be manufactured by Smith, Josam, Wade, or approved equal.

2.7.03 Urinals. Urinals shall be of the type and water use as indicated on the drawings. Urinals shall be of vitreous china, wall mounted, with an elongated rim and washout flushing action, and shall be provided with a top spud connection for a flushometer valve. Urinals shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.03.01 Flush Valves. Flush valves shall be exposed type, of chrome plated brass with an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, and a 3/4 inch (19 mm) NPT water supply connections. Flush valves shall supply a maximum of 1.0 gallon (3.8 L) per flush, and shall be Sloan "Royal 186-1", Delaney, or approved equal.

2.7.03.02 Supports. A fixture support system, including support legs, upper and lower bearing plates, and bearing studs shall be provided for urinals mounted on all walls other than masonry. Urinals mounted on masonry walls shall be provided with suitable anchor bolts. Urinal supports shall be manufactured by Smith, Josam, Wade, or approved equal.

2.7.04 Lavatories. Lavatory types, dimensions, and water use shall be as indicated on the drawings. Lavatories shall be of vitreous china, constructed with overflow drains and soap depressions. Countertop lavatories shall be self-rimming, and shall be provided with suitable adhesive and/or fastening clamps. Wall-mounted lavatories shall be drilled for a concealed arm carrier. Faucet drillings shall be 4 inches (100 mm) on center unless otherwise indicated. Lavatories shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.04.01 Faucets and Trim. Lavatory faucets shall be 4 inches (100 mm) on center, of polished chrome, with a vandal-resistant single-lever handle and all-brass or copper waterways. Each faucet shall be provided with a flow restrictor, a cast brass grid strainer or pop-up drain, and a 1-1/4 inch (32 mm) cast brass tailpiece. Supply sets consisting of 1/2 inch (12.5 mm) NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be furnished for each lavatory faucet. All supply components shall be polished chrome. Where indicated to be ADA-compliant and exposed to human contact, lavatory supplies shall be insulated. Lavatory faucets and supply sets shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.04.02 Traps. Lavatory traps shall be at least 1-1/4 inches (32 mm) in diameter, cast brass with polished chrome finish, with an escutcheon flange and a cleanout plug. Where indicated to be ADA-compliant and if exposed to human contact, lavatory traps shall be offset, insulated type.

When insulation is needed, lavatory supplies and traps may be pre-insulated or furnished with an insulation kit for field installation. Insulating material shall be flame retardant closed cell vinyl. The supply insulating kit shall be snap form type or shall be provided with ties. The trap insulation material shall not require the use of ties or mechanical fasteners to be held in place. Pre-insulated traps and supply insulation kits shall be McGuire Products "ProWrap", or approved equal. Trap and supply insulation kits shall be as manufactured by TRUEBRO Inc, or approved equal.

2.7.04.03 Supports. Wall-hung lavatories shall be provided with a complete fixture support system, including support legs, bearing plates, concealed arms, and anchor bolts. The support legs shall be mounted within the partition wall. For lavatories mounted on masonry walls, support legs may be omitted. Lavatory supports shall be manufactured by Smith, Josam, Wade, or approved equal.

2.7.05 Showers. Shower type, dimensions, and water use shall be as indicated on the drawings.

2.7.05.01 Built-up Shower Stalls. Each built-up shower stall shall be provided with a pressure-balanced single lever mixing valve, a shower head, an arm, and a flange. The shower valve shall include integral service stops and an adjustable stop screw. The shower head shall be of adjustable spray pattern type, with volume control, a swivel ball joint, and an integral flow control device. All exposed components shall be polished chrome.

2.7.05.02 Prefabricated Shower Modules, ADA Compliant. Prefabricated shower modules shall be complete units, and shall meet ADA requirements. Each unit shall consist of a one-piece reinforced acrylic enclosure with stainless steel grab bars on two sides, a folding slatted wood or nylon seat, a 1 inch (25 mm) diameter curtain rod, a 10 ounce/yd^2 (339 g/m^2) shower curtain with hooks, and a 2 inch (51 mm) chrome plated cast brass outlet drain. Each module shall be predrilled for a shower valve, a shower support rod, and a dome light. A pressure-balanced single-lever mixing valve, a hand-held shower head with swivel fitting, a 69 inch (1.7 m) stainless steel flexible hose, a support rod, an in-line vacuum breaker, and a 120 volt dome light shall be provided with each unit. Prefabricated shower modules shall be manufactured by Crane, Kohler, or approved equal.

2.7.05.03 Prefabricated Shower Modules. Prefabricated shower modules shall be provided as complete units. Each unit shall consist of a one-piece reinforced acrylic enclosure with a 1 inch (25 mm) diameter curtain rod, a 10 ounce/yd^2 (339 g/m^2) shower curtain with hooks, and a 2 inch (50 mm) chrome plated cast brass outlet drain. Each module shall be predrilled for a shower valve and dome light. A pressure-balanced single-lever mixing valve and a 120 volt dome light shall be provided with each unit. Prefabricated shower modules shall be manufactured by Crane, Kohler, or approved equal.

2.7.06 Stainless Steel Sinks. Sink dimensions, hole punching, material, metal gage, manufacturer and model shall be as indicated in the schedules.

Stainless steel sinks shall be seamless stainless steel, with smooth radius interior corners. Countertop mounted sinks shall be self-rimming with compartment and faucet deck recessed below the outer edge of the sink. All exposed surfaces of sinks shall be machine polished to a bright finish and the underside shall be fully undercoated. Sinks shall be provided with mounting clips, support legs, and all other hardware as indicated in the schedules. Stainless steel sinks shall be manufactured by Advance Tabco, Elkay, or approved equal.

2.7.06.01 Faucets. Sink faucets shall be polished chrome, with a vandal-resistant single-lever handle. All waterways shall be constructed of brass or copper. Faucets shall be provided with a brass spout, an aerator, and a flow restrictor. Supply sets consisting of 1/2 inch (12.5 mm) NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be provided. All supply components shall be polished chrome. Sink faucets and supply sets shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.06.02 Drain Assembly. All required drainage accessories, including strainers, tailpieces, and traps, shall be provided. Basket strainers shall be heavy gage stainless steel, with a removable conical strainer plate and a neoprene stopper. Tailpieces shall be chrome plated brass. Sink traps shall be at least 1-1/2 inches (38 mm) in diameter, cast brass, with polished chrome finish, an escutcheon flange, and a cleanout plug.

2.7.07 Mop Sinks and Service Sinks. Mop sink and service sink types, dimensions, manufacturers, and models shall be as indicated in the schedules.

Mop sinks shall be floor mounted, corner type, with a diagonal front, constructed of pearl gray terrazzo. Mop sinks shall be provided with an integral 20 gage (0.91 mm) thick stainless steel threshold cap, a 6 inch (150 mm) drop at threshold, and a shoulder at least 1-1/4 inches (32 mm) wide. A 3 inch (75 mm) cast brass drain and stainless steel strainer, and where indicated, a 20 gage (0.91 mm) thick stainless steel splash panel shall be provided for each sink. Mop sinks shall be manufactured by Stern-Williams, Fiat, or approved equal.

Service sinks shall be wall mounted, and shall consist of a 10 inch (254 mm) deep cast iron bowl coated with acid resistant enamel, a stainless steel rim guard, a plain or drilled back as indicated on the drawings, and a heavy gage metal wall bracket. Service sinks shall be manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.07.01 Faucets. Sink faucets shall be rough plated brass, with lever handles, a threaded spout, a vacuum breaker, a wall brace, and a pail hook. The distance from the wall to the center of the spout outlet shall measure approximately 7-1/2 inches (190 mm). Sink faucets shall be as manufactured by Kohler, American Standard, Eljer, or approved equal.

2.7.07.02 Drain Assembly. Mop sinks shall be provided with a 3 inch (75 mm) cast brass drain and a stainless steel strainer. Service sinks shall be provided with a 3 inch (75 mm) cast iron P-type trap standard, with a stainless steel strainer, a cleanout plug, and a threaded outlet.

2.7.08 Emergency Fixtures. Emergency fixtures, including showers, eye/face washes, and combination shower/eye/face wash units shall be furnished and installed where indicated on the drawings. Emergency eyewash shall meet the ANSI Z358.1 Standard and shall provide a minimum tempered water flow of 0.4 gpm at a minimum of 30 psi. Fixture type, manufacturer, and model shall be as indicated in the schedules. Emergency fixtures shall be manufactured by Haws, Guardian, Encon, or approved equal.

Pedestal eyewash shall have a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, a chrome plated trap, and a universal emergency sigh. All necessary accessories required for a complete installation shall be provided.

Indoor emergency eyewash fixtures shall be wall mounted with a wall bracket, a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, a chrome plated trap, and a universal emergency sign. All necessary accessories required for a complete installation shall be provided.

Faucet mounted eyewash shall have a chrome plated brass finish, pull handle with graphics, aerated sprays, and up to 2" thick counter thickness. The unit shall have a dedicated tepid water supply, and shall be manufactured by Speakman, or approved equal.

Indoor ceiling-mounted emergency shower fixtures shall be suitable for vertical supply pipe and flush ceiling mounting, with a pipe support bracket, a chrome plated brass shower head, a stay-open ball valve, a stainless steel pull-rod actuator, and a universal emergency sign. The ball valve shall be located above the ceiling. All necessary piping, support brackets, escutcheons, and accessories required for a complete installation shall be provided.

Combination emergency shower/eye/face wash fixtures shall be pedestal mounted, with a stanchion, a floor flange, a deluge showers, an aerated eye/face wash, an eye/face wash dust cover, stay-open ball valves, interconnecting piping, and a universal emergency sign. The shower shall be stainless steel or ABS plastic with a stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel with push plate and foot pedal actuators.

Freezeproof emergency eye wash fixtures shall be wall mounted with a wall bracket, a stainless steel receptor, ABS plastic heads, a stay-open ball valve, a push plate actuator, and a universal emergency sign. The ball valve shall be located indoors, with an extension stem extending through the exterior wall to the push plate actuator. All necessary drain and bleed piping, wall sleeves, and accessories required for a complete installation shall be provided.

Freezeproof emergency shower fixtures shall be wall mounted, suitable for a horizontal supply pipe, with a pipe support bracket, a stainless steel or ABS shower head, a stay-open ball valve, and a universal emergency sign. The ball valve shall be located indoors, with an actuator extending through the exterior wall. All drain and bleed piping, wall sleeves, and accessories required for a complete installation shall be provided.

Freezeproof combination emergency shower/eyewash fixtures shall be pedestal mounted, with a stanchion, a floor flange, a deluge shower, an aerated eye/face washes, freezeproof stay-open valves, interconnecting piping, and a universal emergency sign. The shower and eye/face wash shall be stainless steel or ABS plastic with a stainless steel actuator. The entire unit shall be provided with self-regulating heating cable and shall be insulated with polyethylene foam insulation. The insulation shall be provided with a removable, UV resistant, ABS plastic jacket with gasketing and removable fasteners. Electric heating cable shall be suitable for the outdoor temperature and power supply indicated on the drawings.

An audible and visual alarm system shall be provided when indicated on the drawings. The alarm system shall activate based on water flow when either the emergency shower or eyewash fixture is operated. The water flow switch shall be provided with double-pole double-throw contacts rated 5 amperes at 125 volts, suitable for remote alarm annunciation. The audible alarm shall provide an intermittent signal rated at 90 dB at 10 feet. The alarm light shall be amber, flashing type. The alarm system shall be pre-wired and shall be furnished with all necessary junction boxes, conduit, wire, and accessories for a complete installation. The alarm system shall be suitable for a 120 volt power supply.

2.7.09 Wash Fountains. Wash fountain type, size, and finish shall be as indicated in the schedules. Wash fountains shall be precast terrazzo with a 9 inch (229 mm) deep bowl, a pedestal support, and stainless steel scuff plates and panels, and shall be suitable for wall or floor type water and waste connections, and a rear or centrally rising vent. Wash fountains shall be complete with a polished chrome liquid or powdered soap dispenser, a thermostatic mixing valve, combination stop/strainer check valves, and all other components required for proper operation. A foot, hand, or infrared control system shall be provided as indicated on the drawings. Infrared control systems shall include transformers as needed for operation on a 120 volt power supply. Wash fountains shall be manufactured by Bradley Corporation, or approved equal.

2.7.10 Electric Water Coolers. Electric water cooler type, capacity, manufacturer, and model shall be as indicated in the schedules. Water coolers shall be wall mounted, mechanically refrigerated type, and shall deliver 50°F (10°C) water at the specified rate, based on 80°F (27°C) inlet water temperature and a room temperature of 90°F (32°C). The water coolers shall consist of a heavy gage steel cabinet, an insulated cooling tank, a stainless steel receptor, copper water lines, a water pressure regulating valve, an adjustable thermostat, and a 3-wire power cord with a polarized plug. The refrigeration unit shall consist of a hermetically sealed spring mounted compressor and an air-cooled condenser. Electric water coolers shall be suitable for a 120 volt, 60 Hz, single phase power supply, shall be UL and ARI listed, and shall be manufactured by Elkay, Oasis, Halsey Taylor, or approved equal.

2.7.11 Food Waste Disposers. Food waste disposer motor size, power supply, and model shall be as indicated on the drawings. Disposers shall consist of stainless steel grinding chamber, grinding elements, impellers, and stopper. Disposers shall be provided with permanently lubricated bearings, a motor overload protector, a tailpiece, a 5 foot (1.5 m) 3-wire power cord with a polarized plug, and a service wrench. Disposers shall be UL listed and shall be manufactured by In-Sink-Erator, or approved equal.

2.8 PLUMBING EQUIPMENT.

2.8.01 General. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

2.8.02 Water Heaters and Accessories. Water heaters shall be furnished and installed where indicated on the drawings. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated in the schedules.

2.8.02.01 Commercial Grade Electric Storage Water Heaters. Electric storage water heaters shall be commercial type, with a glass-lined tank and one or more heating elements. The heater shall be provided with a cold water inlet tube, a magnesium anode, polyurethane foam insulation, a drain valve, and adjustable thermostats. Heating elements shall be immersion type, incoloy sheathed, low or medium watt density, and shall be field replaceable. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). Heater tanks larger than 70 gallons (265 L) shall be provided with an inspection port. Each heater shall be equipped with an ASME rated pressure-temperature relief valve of suitable capacity. Heaters shall be UL and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. Electric storage water heaters shall be manufactured by State Industries Inc., A. O. Smith, Lockinvar, or approved equal.

2.8.02.02 Industrial Grade Electric Storage Water Heaters. Electric storage water heaters shall be industrial type, with a nickel-lined tank and one or more heating elements. Heaters shall be provided with a cold water inlet tube, high density fiberglass insulation, a drain valve, and adjustable thermostats. Heating elements shall be immersion type, incoloy sheathed, low or medium watt density, and shall be field replaceable. Heater tank shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). The heater tanks shall be provided with an inspection port at least 12 inches (300 mm) in diameter. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heater shall be UL and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. The electric storage water heaters shall be manufactured by PVI Industries Inc, or approved equal.

2.8.02.03 Electric Instantaneous Water Heaters. Instantaneous water heaters shall be tankless type and shall heat water on demand as determined by an integral flow switch. Heaters shall be suitable for operating water pressures of 25 to 150 psig (14 to 1034 kPa gauge), and shall be provided with compression type tubing connections. Heater elements shall be constructed of stainless steel or glass reinforced plastic, and shall be replaceable. If required by applicable codes, each heater shall be provided with a temperature and pressure relief valve. Heaters shall be provided with thermostatic control. Electric instantaneous water heaters shall be UL listed and shall be manufactured by Chronomite Laboratories Inc., Eemax, or approved equal.

2.8.02.04 Commercial Grade Gas Fired Water Heaters. Gas fired water heaters shall be commercial, storage type, with a glass-lined tank and a natural or propane gas burner as indicated on the drawings. Heaters shall be provided with a cold water inlet tube, a magnesium anode, high density fiberglass insulation, a drain valve, a flue damper, and an adjustable thermostat. The heater burner shall be atmospheric type, constructed of aluminized steel, and shall be suitable for a minimum gas supply pressure as indicated on the drawings. The burner shall be provided with a gas pressure regulator, a manual reset safety shutoff, and an intermittent electronic ignition control system. Burner operation shall be interlocked with the flue damper to prevent burner and pilot ignition until the flue damper is proven open. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). Heater tanks larger than 70 gallons (265 L) shall be provided with an inspection port. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heaters shall be UL, AGA, and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. Gas fired storage water heaters shall be manufactured by State Industries, A. O. Smith, Lockinvar, or approved equal.

2.8.02.05 Industrial Grade Gas Fired Water Heaters. Gas fired water heaters shall be industrial, storage type, with a nickel-lined tank and a natural or propane gas burner as indicated on the drawings. Heaters shall be provided with a cold water inlet tube, a magnesium anode, high density fiberglass insulation, a drain valve, and an adjustable thermostat. The heater burner shall be forced draft type constructed of cast aluminum, and shall be suitable for a minimum gas supply pressure as indicated on the drawings. The burner shall be provided with a gas pressure regulator, an automatically reset safety shutoff device, and an intermittent electronic ignition control system. The burner combustion chamber shall be submerged, utilizing a minimum of two passes. Heater tank shall be ASME stamped for a working pressure of at least 125 psig (862 kPa gauge). The heater tanks shall be provided with an inspection port at least 12 inches (300 mm) in diameter. An ASME rated pressure-temperature relief valve of suitable capacity shall be provided with each heater. Heaters shall be UL, AGA, and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. Gas fired storage water heaters shall be manufactured by PVI Industries, Inc, or approved equal.

2.8.02.06 Water Heater Flues. A complete flue system shall be provided for each gas fired water heater. Unless otherwise required to maintain the listing of the heater, water heaters utilizing atmospheric burners or fan assisted heaters which operate under a negative flue pressure shall be provided with a Type 'B' flue system. Water heaters utilizing forced draft burners which pressurize the flue shall be provided with a pressurized flue system. Flues shall be as specified in Master Specification Section 15500, Heating, Ventilating and Air Conditioning.

2.8.02.07 Circulating Pump. A circulating pump shall be furnished and installed where indicated on the drawings. Pump capacity, power requirements, manufacturer, and model shall be as indicated on the drawings.

The circulating pump shall be an in-line unit with a bronze body, bronze fitted, mechanical seals, a stainless steel or ceramic shaft, and at least 1/2 inch (13 mm) NPT connections. The circulating pump shall be controlled by a 7-day time clock provided with the pump. The time clock shall be suitable for a 120 volt single phase power supply, and shall have contacts rated for 10 amperes ac. The circulating pump shall be manufactured by Bell & Gossett, Thrush, Taco, or approved equal.

2.8.02.08 Thermometers. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle", or approved equal.

Thermometers shall be bimetal type and shall have a dial at least 4-1/2 inch (114 mm) diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200°F (-10 to 110°C).

Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have 3/4 inch (20 mm) NPT thread mounts, a minimum pressure rating of 250 psig (1725 kPa gauge), and a nominal 4 inch (100 mm) insertion length.

2.8.03 Neutralization Tanks. Neutralization tanks shall be furnished and installed where indicated on the drawings. Tank volume, connection sizes, manufacturer, and model shall be as indicated in the schedules.

Neutralization tanks shall be of heavy-duty construction, rotomolded in one piece from polyethylene resins and equipped with a bolt-down cover of the same material, fastened with stainless steel bolts and washers. Inlet, outlet, and vent fittings molded from the same resins as the tank shall be triple-welded to the tank body at the locations indicated on the drawings. A full diameter flanged extension constructed of the same material as the tank shall be provided where required to raise the access cover to at or just below the floor level as indicated on the drawings. The tank shall be filled with hard limestone or marble chunks, 2 to 3 inches (50 to 75 mm) in diameter to the level recommended by the manufacturer. Neutralization tanks shall be manufactured by Enfield, Orion, Town & Country Plastic, Inc, or approved equal.

2.8.04 Hose Reels. Hose reels shall be furnished and installed at the locations indicated on the drawings. Hose reel type, capacity, manufacturer, and model shall be as indicated in the schedules.

Each hose reel shall be provided complete with a hose storage drum, a handle crank winding mechanism, a spring-actuated pin lock, and a heavy duty frame suitable for anchoring to concrete or masonry wall or floor supports. When indicated on the drawings, hose reels shall be provided with a water supply swivel joint rated at 600 psig (4,130 kPa gauge). The hose storage drum shall be provided with a brass male hose adapter suitable for use with the specified hose. The hose reels shall be manufactured by Hannay, or approved equal.

2.8.05 Hoses. Hoses shall be furnished at the locations indicated on the drawings. Hose type, diameter, manufacturer, and model shall be as indicated in the schedules.

Unless otherwise indicated, each hose shall be provided with one male swivel type brass hose connector, one female brass hose connector, and one regulating wash-up spray nozzle. Spray nozzles in 1 inch (25 mm) and 1-1/2 inch (38 mm) sizes shall be Potter-Roemer Inc. "Series 2970" with a cast brass body, a rubber bumper, and a female hose thread, or approved equal.

Type 1 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig (1030 kPa gauge) working pressure. The hose shall consist of 1-1/2 inch (38 mm) ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 1 hoses shall be Gates Rubber Company "Dolphin", or approved equal.

Type 2 hoses shall be non-collapsible, suitable for water service and shall be rated for 130 psig (900 kPa gauge) working pressure. The hose shall consist of 3/4 inch (19 mm) or 1 inch (25 mm) ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 2 hoses shall be Gates Rubber Company "Industrial Wearmaster", or approved equal.

Type 3 hoses shall be non-collapsible, suitable for hot water service and shall be rated for 200 psig (1380 kPa gauge) working pressure. The hose shall consist of 1 inch ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. The hose shall have an integrated nozzle. The hose end opposite the nozzle shall be furnished with a female thread brass hose connector with swivel. Type 3 hoses shall be Gates Rubber Company "113S", or approved equal.

Type 4 hoses shall be suitable for lay flat water discharge service and shall be rated for 75 psig (500 kPa gauge) working pressure. The hose shall be 1-1/2 inch (38 mm) ID with a heavy-duty polyvinyl chloride (PVC) body and synthetic, high tensile textile cord reinforcement. Type 4 hoses shall be Gates Rubber Company "Masterflex 500", or approved equal.

2.8.06 Oil Interceptor. An oil interceptor shall be furnished and installed where indicated on the drawings. Interceptor capacities, connections, manufacturer, and model shall be as indicated in the schedules.

The oil interceptor shall be of cast iron with an acid resisting coating inside and outside, an adjustable gravity drawoff, a trap with cleanout, 4 inch (102 mm) inlet and outlet connections, vent connections, a removable baffle and sediment bucket, an internal air relief/flow control fitting with access box, and a gasketed cast iron scoriated cover with one bolt securing T-handle. A suitable steel extension shall be provided to raise the access cover to the floor level. The interceptor shall bear the Plumbing and Drainage Institute (PDI) seal of approval and shall be manufactured by Smith, Josam, Wade, or approved equal.

2.8.07 Flammable Waste Interceptor. A flammable waste interceptor suitable for containing oil and other flammable liquids shall be furnished and installed where indicated on the drawings.

The flammable waste interceptor shall consist of a steel or cast iron shell at least 3/16 inch (5 mm) thick, a 4 inch (100 mm) inlet and outlet, and 3 inch (75 mm) vent connections located as indicated on the drawings and as stipulated by the authority having jurisdiction. Steel interceptors shall be coated inside and outside with two coats of black asphaltum.

The interceptor shall maintain a liquid depth of at least 36 inches (0.9 m), and shall have a liquid retention volume of at least 35 cubic feet (1 cubic meter). The inlet piping shall terminate with a 90 degree elbow to 3 inches (75 mm) below the liquid level. The discharge piping shall consist of a 90 degree elbow and pipe terminating 18 inches (450 mm) below the liquid level.

A suitable steel or cast iron extension shall be provided to raise the access cover to the floor level, and a gasketed vaportight steel or cast iron access cover with lifting rings shall also be provided. The cover shall be at least 24 inches (600 mm) in diameter and shall be suitable for a live load of at least 150 psf (7.2 kPa).

2.8.08 Expansion Tanks. Expansion tanks shall be furnished and installed where indicated on the drawings. Tank capacities, connections, manufacturer, and model shall be as indicated in the schedules.

Expansion tanks shall be welded steel diaphragm type, ASME tested and stamped for a working pressure of 125 psig (862 kPa gauge), with a flexible diaphragm and a charging valve. Floor-mounted tanks shall be provided with a suitable mounting base. The tanks shall be suitable for use with potable water and shall be factory pre-charged to the indicated pressure. Expansion tanks shall be manufactured by Amtrol, or approved equal.

2.8.09 Water Storage Tank. The water storage tank shall have the capacity and dimensions as indicated in the schedules. The tank shall be welded steel, glass or thermosetting polymer lined, suitable for use with potable water, and shall be ASME stamped for a working pressure of 125 psig (862 kPa gauge). The tank shall be provided with legs for vertical mounting, a magnesium anode, threaded connections for 2 inch (50 mm) water inlet and outlet, a 1 inch (25 mm) relief valve, and a 3/4 inch (20 mm) drain valve. The outlet and relief valve connections shall be located near the top of the tank; the inlet and drain valve connections shall be located at the bottom of the tank. An ASME rated pressure-temperature relief valve and drain valve shall be provided with the tank. The exterior of the tank shall be thoroughly cleaned, primed, and finished with baked enamel. The water storage tank shall be manufactured by A. O. Smith, PVI, or approved equal.

2.8.10 Automatic Water Softener Unit. An automatic water softener unit shall be furnished and installed where indicated on the drawings. Softener capacities, connections, manufacturer, and model shall be as indicated in the schedules.

The automatic water softener unit shall be furnished with resin tank(s), a brine tank, resin, an electric control system, and all other accessories and appurtenances required for a complete automatic system. The water softening unit shall be manufactured by Culligan, Bruner, or approved equal.

2.8.10.01 Construction. The water softener shall be a factory-assembled, pressure-type consisting of a single unit with resin tank(s) and one brine tank.

Resin tanks shall be constructed of plastic, fiberglass reinforced plastic, or steel with plastic internal liner, and shall be designed for a working pressure of 100 psig (690 kPa gauge). The resin tanks shall be provided with a distribution pipe system to evenly distribute water flow across the media bed and ensure maximum water softening capacity.
The brine tank shall be constructed of high density polyethylene and shall be provided with a cover, a brine fill/discharge valve, an overflow connection, pipe fittings, and required accessories.

2.8.10.02 Media. The softening media shall be high-capacity, sulfonated polystyrene resin that is stable over the entire pH range with good resistance to bead fracture from attrition or shock. The resin shall have a capacity of 30,000 grains of calcium carbonate hardness per cubic foot (66.6 g/L) of resin when regenerated with 15 lbs (6.8 kg) of salt.

2.8.10.03 Controls. The water softening unit shall be provided with a factory installed, automatic, electrically operated control system as indicated on the drawings.

Timer based control systems shall consist of an electric timer which shall initiate regeneration cycles at adjustable time periods.

Timer and flow based control systems shall consist of an electric timer in conjunction with a manually adjustable totalizing flow meter. The system shall initiate regeneration cycles based on water volume or fixed time periods.

Sensor based control systems shall be the solid-state sensor type which initiates regeneration cycles based on sensing water hardness.

Softening units with two resin tanks shall automatically alternate to the standby resin tank at the time of regeneration and shall operate that tank until either the timer or the flow meter senses regeneration of that unit.

All controls shall be capable of manual adjustment and operation. All controls shall be suitable for operation on a 120 volt single phase power supply.

2.9. COLOR Vitreous china, cast iron, enameled steel, and acrylic plumbing fixtures shall be white unless otherwise indicated. Other plumbing fixtures shall be the manufacturers standard color. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.

2.10 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3.3 INSTALLATION. Piping, fixtures, equipment, and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies and as indicated on the drawings. Piping penetrations through fire-rated floors and walls shall be provided with fire-rated sleeves, sealants, and devices as necessary to maintain the rating of the assembly.

Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.

Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems as specified Master Specification Section 15065, Miscellaneous Steel Pipe, Tubing and Accessories.

Fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building.

Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.

3.3.01 Water Supply Piping and Accessories. Water hammer arresters shall be provided in the hot and cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the drawings, arresters shall be located and sized by Contractor in accordance with PDI Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.

Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches (150 mm) of the fixture.

3.3.02 Drainage and Vent Piping and Accessories. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches (75 mm) in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot (2 percent); horizontal sanitary drainage piping larger than 3 inches (75 mm) in diameter shall be installed at a uniform slope of 1/8 inch per foot (3 mm/300 mm); horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot (3 mm/300 mm).

All cast iron, polypropylene, and PVC sanitary and storm drainage piping which is buried beneath floors shall be encased in at least 6 inches (150 mm) of concrete when required. A joint shall be provided in the piping within 12 inches (300 mm) of each end of the encasement.

Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings. Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

Plumbing vents through roofs shall be located at least 12 inches (300 mm) from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches (150 mm) above the flood level rim of the fixture served before offsetting horizontally.

Floor drains shall be adjusted to the correct elevation for proper drainage. Floor cleanouts shall be installed flush with the finished floor. Heads of fastening screws shall be flush with the cover or grate surface.

Cleanouts on sanitary and storm piping inside structures shall be located where indicated on the drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in sanitary and storm drain risers shall be located 12 inches (300 mm) above the finished floor.

Unless otherwise indicated, floor cleanout size shall equal the line size for 4 inch (100 mm) and smaller drainage piping, and 4 inches (100 mm) in diameter for drains larger than 4 inch (100 mm). Proper clearance shall be provided for access to cleanouts.

Floor drains, trench drains, floor sinks, and bell-up drains indicated to be equipped with traps shall be provided with deep seal "P" traps located as close to the drain as possible.

Roof drains shall be set at the proper level for flashing and drainage and shall be securely attached to the roof decks to prevent movement. Overflow roof drain dams or standpipes shall be set at an elevation 2 inches (50 mm) above the low point of the roof.

3.3.03 Plumbing Fixtures and Accessories. Plumbing fixtures shall be set level and plumb, and shall be securely attached to the floor or wall. Unless otherwise indicated on the drawings, each fixture shall be mounted at the height recommended by the manufacturer. Where required to be in compliance with ADA, fixtures shall be mounted at the heights established by the Federal Government.

Fixtures shall be sealed to the floor or wall with a sealant as specified in Master Specification Section 07600, Caulking and Sealers. The color of sealant shall match the color of the fixture.

Fixture traps shall be easily removable for servicing and cleaning. Escutcheons shall be placed at all locations where fixture supply or drain piping penetrates walls, floors, or ceilings.

Water piping at stop valves, shower heads, and flush valves shall be rigidly secured to blocking. Drop-ear elbows shall be used whenever possible. All water supply piping shall be cleaned and flushed before the plumbing fixtures are installed.

3.3.04 Plumbing Equipment. Plumbing equipment shall be installed in accordance with the manufacturer's recommendations. Adequate clearance shall be provided for access to all components which may require adjustment, servicing, or replacement.

Water heaters shall be installed in accordance with AGA, NSF, NFPA, and UL requirements. Storage type water heaters shall be cleaned and flushed before being connected to the potable water system. Water heater relief valves shall be piped to the nearest drain or as indicated on the drawings, and shall terminate the appropriate air gap distance above the drain.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.

Field performance testing of the plumbing piping systems shall conform to Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 ADJUSTING. All flush valves and other devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3.6 PROTECTION. Plumbing fixtures, equipment, and appurtenances shall be protected from damage immediately after installation. Plumbing fixtures shall not be used during the construction.

3.7 CLEANING. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer. All faucet aerators shall be removed, cleaned, and reinserted.

Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3.8 DISINFECTION. Before the potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:

1. The system shall be purged with clean potable water until all dirt and other substances are flushed from the system.

2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million (50 mg/L) of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million (200 mg/L) of available chlorine and allowed to stand for 3 hours.

3. The system shall be purged with clean potable water until the chlorine is flushed from the system.

4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

3.9 OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as indicated.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

SECTION 15430

BACK FLOW PREVENTERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installing of backflow preventers and associated appurtenances.

1.2 RELATED DOCUMENTS. Drawings and general provisions of the Contract, including Division 1 Specification Section, apply to this Section.

1.3 SUBMITALS.

1.3.01 Drawings and Data. Complete fabrication and assembly drawings, together with detail specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Mater Specification Section 01080, The data and specifications for each unit shall include, but shall not be limited to the following:

Name of Manufacturer.

Type and model.

Net weight.

Unit dimensions.

Performance curves indicating flow capacity versus pressure drop.

Manufacturer shall submit certification that each backflow preventer and all appurtenances furnished is in accordance with the reference standards. Submit pressure, vacuum and temperature ratings of backflow preventer.

Contractor shall submit results of all pressure and leakage testing.

Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manual shall be submitted in accordance with Master Specification section 01160, Training and Operation Manuals.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS*.* Shall be Febco-860, Watts Regulator Company–909, or as approved.

Provide an air gap fitting between relief valve outlet and drain line. Provide all required drain piping and fittings from the relief valve outlet to the nearest floor drain or other approved outlet.

2.1.01 Reduced Pressure Backflow Preventers. AWWA/ANSI C511; ductile iron body, epoxy coated interior and exterior, and flagged resilient seated gate valve on each end of the device. Flange diameter and drilling shall confirm to ANSI/ ASTM B16.1, Class 125.

2.1.02 Double Check Valve Assemblies. ANSI/ASSE 1012; bronze body with corrosion- resistant internal parts and stainless steel springs; and two independently operating check valves.

PART 3 – EXECUTION

3.1 INSTALLATION. Install in accordance with manufacturer's instructions.

Pipe relief from backflow preventer to nearest drain.

End of Section

SECTION 15480

GENERAL SERVICE COMPRESSED AIR PIPING

PART 1 - GENERAL

1.1 SCOPE. This section covers general service compressed air piping to be installed in the Rack and Grit building indicated in the Contract Documents.

1.2 SUMMARY. This Section includes piping and related specialties for general-service compressed-air systems operating at 100 psig (1380 kPa) and less.

1.3 RELATED SECTIONS. Related Sections include the following:

Division 15 Section 15130- “Indicating Devices” for thermometers and pressure gages.

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 DEFINITIONS.

ABS: Acrylonitrile-butadiene-styrene plastic.

CR: Chlorosulfonated polyethylene synthetic rubber.

EPDM: Ethylene-propylene-diene terpolymer rubber.

FPM: Vinylidene fluoride-hexafluoropropylene copolymer rubber.

HDPE: High-density polyethylene plastic.

Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 125 psig (860 kPa) and less.

1.4 SUBMITTALS. All submittals required in this section shall be provided in accordance with Master Specification Section 01080, Project Submittals, unless otherwise indicated.

1.4.01 Product Data. Submit product data for the following:

Pipes, tubes, and fittings.

Flexible pipe connectors.

Safety valves.

Pressure regulators.

Filters.

Automatic drain valves.

Hose couplings.

Hose assemblies.

1.4.02 Coordination Drawings. For general-service compressed-air systems. Include relationship to other services that serve same work area.

1.4.03 Brazing Certificates. As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

1.4.04 Welding Certificates. As required by ASME Boiler and Pressure Vessel Code, Section IX.

1.4.05 Field quality-control test reports. Submit reports with results of field quality-control tests.

1.5 QUALITY ASSURANCE.

1.5.01 Brazing. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

1.5.02 Welding. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1.5.03 Standards. Comply with the following:

ASME B31.1, "Power Piping," for high-pressure compressed-air piping.

ASME B31.9, "Building Services Piping," for low-pressure compressed-air piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection.

2.1.01 Available Manufacturers. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 PIPING MATERIALS. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PIPES, TUBES, AND FITTINGS.

2.3.01 Schedule 80, Steel Pipe. ASTM A 53/A 53M, Type E or S, Grade A or B, black or hot dip, zinc coated. Provide Type S, Grade B, and hot-dip zinc-coated pipe options if indicated.

2.3.01.01 Steel Nipples. ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 80, galvanized seamless steel pipe. Include ends matching joining method.

2.3.01.02 Malleable-Iron Fittings. ASME B16.3, Class 150 , threaded. Provide Class 300 and galvanized finish if indicated.

2.3.01.03 Malleable-Iron Unions. ASME B16.39, Class 150 , threaded. Provide Class 300 if indicated.

2.3.01.04 Steel-Piping Grooved-End Fittings. ASTM A 47/A 47M, malleable-iron casting; ASTM A 106, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe; and made by keyed-coupling manufacturer. Provide galvanized finish if indicated. Available Manufacturers:

Central Sprinkler Co.; Central Grooved Piping Products.

Grinnell Corp.

Star Pipe Products, Inc.; Star Fittings Div.

Victaulic Corp. of America.

Ward Manufacturing, Inc.

2.3.02 Transition Couplings for Metal Piping. Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3.03 Flexible Pipe Connectors. Corrugated tubing with wire-braid covering. Available Manufacturers:

ANAMET Inc.

Flex-Hose Co., Inc.

Flexicraft Industries.

Hyspan Precision Products, Inc.

Mercer Rubber Co.

Metraflex, Inc.

Proco Products, Inc.

Unaflex, Inc.

2.3.04 Stainless-Steel-Hose/Steel Pipe Flexible Pipe Connectors. Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

Working-Pressure Rating: 200 psig (1380 kPa) minimum.

End Connections NPS 2 (DN 50) and Smaller: Threaded steel pipe nipple.

End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

Refer to Division 15 Section 15019 "Exposed Piping Installation” for joining materials not in this Section.

2.4 VALVES.

2.4.01 General-Duty Valves. Refer to Division 15 following sections:

Section 15091, “Miscellaneous Ball Valves” "Valves"

Section 15093, “Check Valves”

Section 15096, “Globe Valves”

Section 15100, “Miscellaneous Valves”

2.5 SPECIALTIES.

2.5.01 Safety Valves. ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet safety valve for compressed-air service.

Pressure settings to be higher than discharge pressure and same or lower than receiver pressure rating.

2.5.02 Air-Main Pressure Regulators. Bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psig (1725-kPa) inlet pressure, unless otherwise indicated.

Type: Pilot operated.

2.5.03 Air-Line Pressure Regulators. Aluminum alloy or plastic body, diaphragm operated, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 100-psig minimum inlet pressure, unless otherwise indicated.

2.5.04 Mechanical Filters. Two-stage, mechanical-separation-type, air-line filters in sizes and ratings indicated. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock.

2.5.05 Automatic Drain Valves. Corrosion-resistant metal body and internal parts, rated for 100-psig (1380-kPa) minimum working pressure, capable of automatic discharge of collected condensate.

2.5.06 Hose Couplings. Shall be Chicago Fitting type. Assembly with locking-mechanism feature for connection and disconnection of compressed-air hose.

Available Manufacturers:

Aeroquip Corporation.

Bowes Manufacturing, Inc.

Parker Hannifin Corporation; Fluid Connectors Group; Quick Coupling Div.

Rectus GMBH; Parker Div.

Schrader-Bridgeport; Amflo Div.

Schrader-Bridgeport/Standard Thomson.

Snap-Tite, Inc.

TOMCO Products Inc.

Tuthill Corporation; Hansen Coupling Div.

2.5.07 Hose Assemblies. Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 200-psig (2070-kPa minimum working pressure, unless otherwise indicated.

Hose: Reinforced single wire-braid, CR-covered hose for compressed-air service.

Hose Clamps: Stainless-steel clamps or bands.

Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with serrated ends for connecting two sections of hose.

Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with serrated ends for connecting two sections of hose.

2.6 IDENTIFICATION. Refer to Division 15 Section 15825 "Mechanical Identification" for identification of piping, valves, gages, and specialties.

PART 3 - EXECUTION

3.1 PREPARATION.

3.1.01 Interruption of Existing Compressed-Air Service. Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

Notify Owner not less than 25 days in advance of proposed interruption of compressed-air service.

Do not proceed with interruption of compressed-air service without Owner's written permission.

3.2 PIPING APPLICATIONS. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below, unless otherwise indicated.

3.2.01 Joining of Dissimilar Metal Piping. Use dielectric fittings. Refer to Division 15 Section 15019 "Exposed Piping Installations" for dielectric fitting types.

NPS 2 (DN 50) and Smaller: Dielectric unions.

NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric flanges.

3.2.02 Specialty and Equipment Flanged Connections. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

3.2.03 General-Service Compressed-Air Piping Between Air Compressors And Air Receivers. Use metal general-service compressed-air piping between air compressors and air receivers. Use of plastic piping for this application is prohibited.

3.2.04 Low-Pressure Compressed-Air Piping between Air Compressors and Receivers. Use any of the following piping materials for each size range:

NPS 2 (DN 50) and Smaller: Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

3.2.05 Low-Pressure Compressed-Air Distribution Piping. Use any of the following piping materials for each size range:

NPS 2 (DN 50) and Smaller: Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

3.2.06 Receivers. Use the following piping materials for each size range:

NPS 2 (DN 50) and Smaller. Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

NPS 2-1/2 to NPS 4 (DN 65 to DN 100). Schedule 80, black-steel pipe; threaded malleable-iron fittings; and threaded joints.

3.3 VALVE APPLICATIONS.

3.3.01 General-Duty Valves. Refer to Division 15 Section 15010 "Valve Installation" for metal general-duty valves. Use metal valves, unless otherwise indicated.

3.3.01.01 Metal General-Duty Valves. Use valve types specified in the schedule of valves in Division 15 Section 15010 "Valve Installation" according to the following:

Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.

Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

Grooved-end valves may be used with grooved-end piping and grooved joints.

3.4 PIPING INSTALLATION. Refer to Division 15 Section 15019 "Exposed Piping Installation" for basic piping installation.

Install air and drain piping with 1 percent slope downward in direction of airflow.

Install eccentric reducers where piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

Install flexible pipe connector on each connection to air compressors.

Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver; install according to Division 15 Section 15130 "Indicating Devices."

Install pipe expansion joints and anchors according to Division 15 Section 15019 "Exposed Piping Installation."

3.5 VALVE INSTALLATION. Refer to Division 15 Section 15019 "Exposed Piping Installation" for basic piping and valve installation.

Install metal general-duty valves according to Division 15 Section 15010 "Valve Installation."

Install plastic valves according to plastic piping manufacturer's written instructions.

Install shutoff valve at each connection to and from general-service compressed-air specialties, equipment, and accessories. Install strainer if indicated.

Install check valves to maintain correct direction of fluid flow to and from compressed-air piping specialties and equipment.

Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

Install automatic drain valves on intercoolers, aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

Install safety valves where recommended by specialty manufacturers.

3.6 JOINT CONSTRUCTION. Refer to Division 15 Section 15019 "Exposed Piping Installation" for basic piping joint construction.

Pressure-Seal Joints. Select correct type of O-ring seals. Make joints with fitting manufacturer's tools and according to fitting manufacturer's written instructions.

Grooved Joints. Select correct type of gasket. Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling manufacturer's written instructions. Do not apply lubricant to pre-lubricated gaskets.

Copper Tubing Joints. Join copper tubing with brazed joints. Use silver-composition or copper-phosphorus-composition filler metal and comply with CDA's "Copper Tube Handbook," Section VII, "Brazed Joints."

Dissimilar Metal Piping Material Joints. Use dielectric fittings.

3.7 HANGER AND SUPPORT INSTALLATION. Refer to Division 15 Section 15140 "Pipe Supports" for pipe hanger and support devices. Install the following:

Vertical Piping: MSS Type 8 or 42, clamps.

Individual, Straight, Horizontal Piping Runs: According to the following:
100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.

Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

Base of Vertical Piping: MSS Type 52, spring hangers.

Install supports according to Division 15 Section 15140 "Pipe Supports."
Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

Support vertical piping and tubing at base and at each floor.

Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

Install hangers for Schedule 80, steel piping with the following maximum horizontal spacing and minimum rod diameters:

NPS 1/4 to NPS 1/2 (DN 8 to DN 15): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

NPS 3/4 to NPS 1-1/4 (DN 20 to DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

NPS 1-1/2 (DN 40): 12 feet (3.7 m) with 3/8-inch (10-mm) rod.

NPS 2 (DN 50): 13 feet (4 m) with 3/8-inch (10-mm) rod.

NPS 2-1/2 (DN 65): 14 feet (4.3 m) with 1/2-inch (13-mm) rod.

NPS 3 (DN 80): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

NPS 3-1/2 (DN 90): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.

NPS 4 (DN 100): 17 feet (5.2 m) with 5/8-inch (16-mm) rod.

Install supports for vertical, Schedule 80, steel piping every 15 feet (4.6 m).

NPS 3-1/2 (DN 90): 15 feet (4.6 m) with 1/2-inch (13-mm) rod.

NPS 4 (DN 100): 16 feet (4.9 m) with 1/2-inch (13-mm) rod.

NPS 3 (DN 80): 68 inches (1730 mm) with 1/2-inch (13-mm) rod.

NPS 4 (DN 100): 76 inches (1900 mm) with 1/2-inch (13-mm) rod.

All Sizes: Install continuous support for piping with compressed air at normal operating temperature above 100 deg F (38 deg C)

NPS 1/2 (DN 15): 30 inches (760 mm) with 3/8-inch (10-mm) rod.

NPS 3/4 (DN 20): 36 inches (910 mm) with 3/8-inch (10-mm) rod.

NPS 1 (DN 25): 40 inches (1015 mm) with 3/8-inch (10-mm) rod.

NPS 1-1/4 (DN 32): 43 inches (1090 mm) with 3/8-inch (10-mm) rod.

NPS 1-1/2 (DN 40): 49 inches (1245 mm) with 3/8-inch (10-mm) rod.

NPS 2 (DN 50): 55 inches (1400 mm) with 3/8-inch (10-mm) rod.

NPS 3 and NPS 4 (DN 80 and DN 100): 96 inches (2440 mm) with 1/2-inch (13-mm) rod.

3.8 CONNECTIONS. Drawings indicate general arrangement of piping, fittings, and specialties.

Install piping adjacent to specialties and equipment to allow service and maintenance.

Connect piping to air compressors, accessories, and specialties with shutoff valve and union or flanged connection.

3.9 LABELING AND IDENTIFICATION. Install identifying labels and devices for general-service compressed-air piping systems. Refer to Division 15 Section 15825 "Mechanical Identification" for labeling and identification materials.

3.10 FIELD QUALITY CONTROL. Perform the following field tests and inspections and prepare test reports:

Test and adjust piping safety controls. Replace damaged and malfunctioning safety controls.

Piping Leak Tests: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

Repair leaks and retest until no leaks exist.

Report results in writing.

End of Section

SECTION 15482

LABORATORY COMPRESSED AIR SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers laboratory compressed air systems to be installed in the locations indicated in the Contract Documents.

The compressed air package shall include a compressor, an electric drive motor, a motor starter, belts, sheaves, safety guards, receiver, air dryer, controls, traps, valves, piping, baseplate, and all accessories and appurtenances specified, indicated on the drawings, or otherwise required for a complete, properly operating installation.

All required interconnecting air piping and valves between package components shall be provided under this section.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Components of the compressed air equipment package shall be the latest standard products of manufacturers who regularly produce equipment of this type.

All components of the compressed air equipment package shall be shop assembled on a common baseplate. The arrangement shall permit access from the front and ends of the package for maintenance of components.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Power Supply. Power supply to the compressors will be 480 volts, 60 Hz, 3 phase. Power supply to the dryer will be 120 volts, 60 Hz, single phase.

1.3 SUBMITTALS. Complete assembly and installation drawings, together with detailed specifications and data covering all equipment and accessories furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Electrical schematics, wiring diagrams, and panel layout drawings for compressor controls shall be included. Data and specifications for each unit shall include, but shall not be limited to, the following:

<u>Baseplate</u>

Overall dimensions.

Number, size, and location of structural members.

Thickness of top plate.

Number, size, and location of grout openings.

Drawings indicating pipe routing, traps, and valve locations.

<u>Compressor</u>

Manufacturer.

Type and model.

Piston speed.

Dimensions.

Weight, including motor.

Performance data at variable discharge pressures.

Bearing data.

<u>Motors</u>

Manufacturer.

Type and model.

Horsepower (kW) rating and service factor.

Temperature rating.

Full load rotative speed.

Type of bearings and lubrication.

Full load current.

Locked rotor current.

Efficiency at nameplate rating and at operating point.

Power factor at nameplate rating.

Receiver

Capacity.

Pressure rating.

Dimensions.

Connection sizes and locations.

Verification of ASME Code stamp.

Air Dryer

Manufacturer.

Model.

Performance data.

Pressure drop.

1.4 OPERATION AND MAINTENANCE MANUALS. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.6 SPARE PARTS. The following spare parts shall be furnished for each compressed air equipment package:

Part Description	Number Required
Intake air filter elements	2

V-belts	2 matched sets
Inlet valve assembly	1
Inlet valve springs	1 set
Discharge valve assembly	1
Discharge valve springs	1 set
Piston rings	1 set for each size piston

Spare parts shall be suitably packaged in accordance Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The system shall supply compressed air to laboratory outlets only. The air shall be dry and oil free.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The performance and design requirements shall be as indicated.

The approximate elevation of the site will be as indicated on the drawings. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.3 CONSTRUCTION.

2.3.01 Compressors. The compressors shall be single or two-stage as indicated, air-cooled reciprocating type and shall deliver oil-free air. Pistons shall be fabricated from materials which do not require oil lubrication. Cylinders and crankcases shall be of cast iron construction. Piston rings shall be teflon. Compressor cylinder valves shall be of the finger, channel, leaf, or ring type and shall be fabricated from corrosion-resistant materials suitable for nonlubricated service. Cylinders and cylinder heads shall be designed so that the compressor sheave provides all required external forced air circulation. The compressors shall be constructed with a distance piece between the compression cylinder and the crankcase lubricant system. The distance piece shall consist of an atmospheric chamber arranged to drain back into the crankcase. Portions of the piston rod in contact with the lower seal shall not enter the upper seal area. A collar shall be provided on the piston rod to prevent oil from traveling along the rod. Piston rod packing shall be teflon or carbon, nonlubricated type.

Each crankshaft shall be cradle-mounted with antifriction roller or ball type main bearings. Connecting rod bearings shall be steel backed, babbitt-lined, insert type plain bearings. Connecting rod and crankshaft bearings shall be lubricated by a force feed positive lubrication system. A lubrication system pressure gauge, of the compressor manufacturer's standard size and range, shall be furnished with each compressor.

Each compressor shall be driven by an electric motor connected to the compressor through a V-belt drive.

2.3.02 Package Receiver. The receiver shall be of all welded construction with semi-ellipsoidal heads and leg supports for vertical mounting on the common baseplate. The receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp.

The receiver shall be provided with piping connections for inlet, outlet, drain, safety valve, compressor control, receiver vent, and cleanout opening. The receiver shall be hot-dip galvanized and shall have an automatic float-operated condensate drain trap.

2.3.03 Air Dryer. The air dryer shall be of the air-cooled noncycling refrigerant type and shall produce a 33 to 39°F (1 to 4°C) pressure dew point at the heat exchanger exit when operating continuously at the design conditions. The air dryer shall be Hankison Refrigifilter "Model 8025", or approved equal.

The dryer shall consist of a heat exchanger, separators, hermetically sealed refrigeration unit, and self-regulating hot gas bypass valve. The dryer shall be completed with "On-Off" manual motor switch, running light, evaporator performance gauge, intake air thermometer, and automatic float-operated condensate drain trap. The dryer shall include a condenser, integral moisture separator, and a cartridge filter of the acetate fiber type, completely enclosed in an ASME pressure vessel and designed for a pressure of 150 psi (1035 kPa).

2.3.04 Piping. All interconnecting piping and tubing between components of the equipment package shall be shop installed.

Piping from the compressor discharge to the receiver shall be sized not less than the compressor discharge connection size and shall be ASTM A53, seamless, Grade B, Schedule 40 black steel pipe with ANSI B16.11, Class 3000, forged steel socket-welding fittings, or Schedule 80 black steel pipe with Class 3000 forged steel threaded fittings. "Close" nipples will not be acceptable.

Pneumatic control and instrument tubing connected directly to the compressor shall be ASTM A269, Type 304 or 316 stainless steel tubing with Parker Hannifin "CPI", Crawford "Swagelok", or approved equal, Type 316 stainless steel compression fittings. Tubing shall be not less than 1/4 inch (25 mm) OD with a wall thickness of 0.028 inch (0.71 mm).

Piping between the package receiver and the air dryer shall be ASTM B88, Type K, hard drawn copper tubing with ANSI B16.18 or B16.22 solder-joint fittings.

All piping and tubing shall be run in vertical and horizontal planes and shall not contact the baseplate. Piping shall be arranged to ensure that undue stresses from thermal expansion are not transmitted to equipment components. All control and instrument tubing shall be continuously supported.

Compressor discharge piping shall be sloped to drain to the receiver and shall include a drip trap to prevent condensate in the discharge piping from draining back to the compressor.

Drainlines from each compressor, air dryer, and receiver shall be piped to the edge of the baseplate. Receiver and air dryer drainlines shall be combined downstream of the traps.

2.3.05 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) opening galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.3.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of the equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

2.3.07 Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes.

The baseplate shall be constructed of heavy steel plate and structural members and shall be designed for not measurable deflection with the equipment mounted thereon and the baseplate supported around its perimeter. The base shall be designed so that all equipment bolted to it can be removed without access to the underside of the plate and with a flat top surface for ease of cleaning. Structural stiffeners shall be located under the compressors at the compressor anchor points. A drip lip will not be required.

2.3.08 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion
Anchors, unless otherwise indicated on the drawings.

2.3.09 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.3.10 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for coating as recommended by the paint manufacturer for the intended service, and then shop coated with one or more coats of the specified primer.

Machined and polished surfaces shall be coated with rust-preventive compound as recommended by the manufacturer.

All iron and steel surfaces, except galvanized surfaces and stainless steel, shall be thoroughly cleaned, sanded, and shop primed with one or more coats of universal primer, followed by two or more finish coats of epoxy enamel.

Galvanized surfaces shall be prepared for coating in accordance with the instructions of the primer manufacturer. Galvanized surfaces shall be shop primed with two or more coats of universal primer, followed by two or more finish coats of epoxy enamel.

Stainless steel, nonferrous metallic, and nonmetallic surfaces shall not be coated.

Epoxy enamel products for NSF certified systems shall be Ameron "Amerlock 400 High Solids Epoxy Coating", Carboline "Carboguard 891", Tnemec "Series N140 Pota-Pox Plus", or approved equal. Where NSF certification is not required, the epoxy enamel products shall be Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", Tnemec "Series 69 Hi-Build Epoxoline II", or approved equal.

The total paint dry film thickness, including prime coat and finish coats, shall be not less than 5 mils (125 µm). The color shall be safety green in accordance with ANSI Z53.1.

One quart of finish paint shall be provided with the equipment package for field touchup coating.

2.4 ACCESSORIES. Each compressed air equipment package shall be furnished with the following accessory equipment.

2.4.01 Valves.

2.4.01.01 Safety Valves. Safety valves with manual lifting levers shall be installed in the compressor discharge piping and on the receiver as indicated on the drawings. Valves in the compressor discharge piping shall be capable of protecting the compressors from damage when operating against a closed discharge valve and shall be suitable for the maximum compressor discharge air temperature.

The safety valve on the receiver shall be capable of protecting the receiver from excessive pressure.

2.4.01.02 Discharge Check Valves. A line-mounted check valve shall be provided in the discharge piping leading from the compressor. The check valves shall be sized in accordance with the manufacturer's recommendations and shall be suitable for service with reciprocating compressors at the maximum compressor discharge air temperature.

Check valves shall be disc and spring type, designed for installation in the discharge piping from reciprocating compressors, and shall be Hoerbiger "Compact-A-Check" valves, or approved equal. Combination unloading devices/check valves will not be acceptable.

2.4.01.03 Shutoff Valves. All shutoff valves shall be ball valves. Valves in steel piping shall have carbon steel bodies, chrome plated or stainless steel balls, and reinforced teflon seals and seats. Shutoff valves in stainless steel tubing shall be Type 316 stainless steel balls and reinforced teflon seals and seats. Valves in copper tubing shall have bronze bodies; chrome plated, stainless steel, or bronze balls; and reinforced teflon seals and seats. Valves in the compressor discharge piping shall be suitable for the maximum compressor discharge air temperatures.

2.4.01.04 Receiver Vent Valve. A globe type vent valve with bronze body and brass stem shall be provided on the each receiver.

2.4.02 Belts and Sheaves. All required belts and sheaves shall be furnished. Belts and sheaves shall be of the heavy-duty "V" type. Belts for each compressor shall be matched sets.

2.4.03 Intake Filter Silencers. Each compressor shall be provided with a bottom outlet, dry type intake filter silencer supported by the suction pipe and close-coupled to the compressor intake connection. Intake filter silencers shall have an outer cover and a replaceable filter element. Silencers shall be constructed of steel and shall be sized in accordance with the recommendations of the manufacturer. Sound attenuation shall be not less than 20 dB at 1,000 Hz; particle arrestance shall be not less than 99 percent at 25 micron size, and 70 percent at 5 micron size.

2.4.04 Pressure Gauges. Each pressure gauge shall have a phenol case, adjustable pointer, and stainless steel rotary geared movement. Each gauge shall be accurate to within 2 percent of full scale. Gauges shall have a minimum dial size of 4-1/2 inches (115 mm) and a range equal to approximately twice the normal operating pressure at the point of installation. The units of measurement shall be indicated on the dial face.

Panel-mounted gauges shall have a 1/4 inch (6 mm) NPT connection. All other gauges shall have a 1/2 inch (12.7 mm) NPT connection. All gauges shall be provided with a ball valve.

2.4.05 Pressure Switches. Each pressure switch shall have spdt contacts rated 10 amperes at 120 volts ac and shall be completed with shutoff valve. Pressure switches mounted inside the control panel shall have NEMA Type 1 housings.

2.4.06 Thermometers. Thermometers shall be of the remote reading mercury or gas actuated dial type. Thermometers shall have a minimum dial size of 4-1/2 inches (115 mm) and an adjustable pointer, and shall be accurate within 1 percent of full scale. Thermometers shall be furnished complete with a uniformly graduated dial indicator, armored capillary tube, bulb or temperature sensor, and thermowell. Thermometer ranges shall be such that the normal operating reading will be near the midpoint of the range. The units of measurement shall be indicated on the dial face. Spare capillary length shall be neatly coiled and tied.

Air piping shall be increased in size at the thermowell location so that the area between the well and the pipe is not less than the cross-sectional area of the original size piping. The entire sensitive length of the temperature sensor shall be installed within the airflow stream.

2.4.07 Temperature Switches. Temperature switches shall be remote bulb type with spdt contacts rated 10 amperes at 120 volts ac. Temperature switches shall have NEMA Type 1 housings, stainless steel thermowell assemblies, and armored capillaries. Capillary length shall be sufficient for mounting the switch inside the control panel. Spare capillary length shall be neatly coiled and tied.

Air piping shall be increased in size at the thermowell location so that the area between the well and the pipe is not less than the cross-sectional area of the original size piping. The entire sensitive length of the temperature sensor shall be installed within the airflow stream.

2.5 CONTROL EQUIPMENT. All control equipment for the compressor shall be furnished as necessary for a complete installation requiring only field connection of the remote alarm, and electrical power supply supplies. Equipment shall include all control switches, pressure switches, timing relays, auxiliary relays, unloaders, circuit breaker combination magnetic motor starter and other accessories required for control of the compressor. The starter shall include a thermal-magnetic circuit breaker with external operating handle and a control transformer with a 120 volt secondary, one secondary lead fused and the other grounded. Starter overload (one per phase) shall be matched to motor current and shall be provided with a "Reset" push button.

All control equipment for the compressor package, except for the high discharge temperature switches and loading controls, for the compressor, shall be housed in a control panel of NEMA Type 12 construction, mounted on the package.

All system wiring shall be shop installed to terminal blocks in the control panel. Wiring from the panel to system components shall be completely enclosed in liquid-tight flexible conduit.

All pneumatic tubing shall be shop installed to bulkhead fittings at the control panel. All field connections shall be made to the fittings at the panel.

2.5.01 Control Panel. The control panel shall be fabricated from 14 USS gage or heavier steel and shall be equipped with an approximately full-size gasketed door with chromium plated or stainless steel three-point latch and hinges. A screened vent shall be provided in the bottom of the control panel. All control devices shall be rigidly mounted within the enclosure except for breaker handles, selector switches, push buttons, and indicating lights, which shall be mounted on the panel door.

Numbered terminal blocks in the control panel and identical terminal blocks at the equipment shall be provided for those items needing field wiring between the control panel and the compressed air equipment. All items at the compressors shall be wired to terminal blocks.

Numbered bulkhead fittings at the control panel, corresponding to identical numbers at the equipment, shall be provided for all pneumatic tubing requiring field connections between the control panel and equipment. Internal panel tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipping without damage. Compression type bulkhead fittings shall be provided through the panel for all connections.

Internal panel wiring shall be neatly bundled and tied and shall be identified with suitable wire markers. Terminal blocks for external connections shall be furnished complete with marking strips, coves, and pressure connectors. A terminal shall be provided for each conductor or external circuits. All wiring shall be grouped or cabled and securely attached to the panel. Clearance for field wiring shall be provided between the terminal strips and base.

All panel equipment, wiring, and tubing shall be shop installed.

2.5.02 Compressor Control. The compressed air package shall be furnished with a control system which shall start and stop the compressors as necessary. The control system shall unload the compressors on shutdown and while coming up to speed during startup. Unloading shall be accomplished by inlet valve control.

Each compressor shall be provided with a control switch with "Lead-Off-Lag" positions. Two pressure switches with separately adjustable settings shall be furnished for the compressor, one for "Lead" and one for "Lag" control.

The control system shall start and stop the compressors at the following pressures:

Lead compressor start pressure, psig (kPa gauge)	90 (620)
Lag compressors start pressure, psig (kPa gauge)	100 (690)
Compressors stop pressure, psig (kPa gauge)	120 (830)

2.5.03 Protection Controls. A protection control system shall be provided for each compressor. The control system shall stop the compressor on high discharge air temperature.

2.5.04 Miscellaneous Controls. A dial type thermometer shall be furnished for the compressor air discharge. A package receiver pressure gauge and the compressor air discharge thermometers shall be mounted on a wing projection on top of the control panel.

White indicating lights shall be provided on the control panel to indicate the following alarm conditions:

Compressor motor overload.

High compressor discharge air temperature.

Low receiver pressure.

Indicating lights shall be heavy-duty, oiltight, semiflush type with escutcheon plates to identify the malfunction. A mechanical latching relay circuit with a common "Reset" push button shall be provided so that the alarm lights remain on until manually reset. The latching relays shall have a contact rated 10 amperes at 120 volts, which closes on alarm. An alarm light "Test" push button shall also be provided on the front of the control panel to test the lights simultaneously without actuating the remote alarm.

A normally open contact, which close under alarm conditions, shall be provided for remote alarm. The contact shall close when any alarm occurs. Contact shall be rated 10 amperes at 120 volts, 60 Hz, single phase.

The pressure switch for low receiver pressure shall have adjustable contacts set to close when the receiver pressure falls to 80 psig (550 kPa gauge).

The compressor shall be provided with an elapsed time hour meter mounted on the front of the control panel.

2.6 ELECTRIC MOTORS. Each motor shall be complete with an adjustable baseplate for mounting on the common baseplate. Motors shall be rated at 460 volts, 60 Hz, 3 phase.

Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor. Drive units shall be designed for 24 hour continuous service.

2.7 SHOP TEST. Prior to shipment, the compressor and dryer shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or wells; and proper operation of the safety and operating controls. Compressor pressure controls shall be adjusted to the specified pressures. Defective equipment and controls disclosed by such tests shall be replaced and the package placed in the satisfactory operating conditions before shipping. A statement from the package supplier certifying that the specified shop test has been performed shall be submitted to Engineer prior to shipment.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

End of Section

SECTION 15484

LABORATORY VACUUM SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers vacuum equipment serving the laboratory area, including the equipment, piping, valves, fittings, gauges, bases, anchor bolts, and other accessories and appurtenances required for a complete unit.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools, shall apply to all equipment furnished under this section.

1.2.02 Power Supply. The power supply to the equipment shall be as indicated.

1.2.03 Mechanical Identification.

1.2.03.01 Number Plates. Equipment specified herein shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Nameplates shall have black baked enamel letters on anodized aluminum plate. Number plate symbols and numbers shall be capitalized block letters with a minimum height of 3/4 inch (19 mm). Number plate height shall be twice the letter height. Number plates shall be at least 12 gage (2.66 mm) thickness. Number plates shall be installed with corrosion-resistant mechanical fasteners.

1.2.03.02 Equipment Plates. Equipment specified herein shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3 SUBMITTALS. Complete schematic and wiring diagrams, assembly and installation drawings, together with detailed specifications and data covering material used, power drive assembly, motors, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. Performance and design requirements shall be as indicated.

The approximate elevation of the site will be as indicated on the drawings. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.2 CONSTRUCTION. The vacuum system shall include, but shall not be limited to, simplex or duplex vacuum pumps as required, vacuum receiver tank, oil reclaimer, combination motor starters, control switches, piping, check valves, gauges and miscellaneous accessories to make a complete packaged unit.

2.2.01 Vacuum Pumps. Each pump shall be air-cooled, lubricated, rotary vane type and shall be driven by an electric motor mounted on the same base as the pump. The pumps and motors shall be factory mounted, wired, and piped on a horizontal receiver tank. The vacuum pumps shall be designed or equipped with a discharge exhaust filter or muffler to minimize discharge of oil to the atmosphere.

2.2.02 Receiver Tank. The receiver tank shall be horizontal type, of welded construction, with semi-ellipsoidal heads and with leg supports suitable for mounting on a concrete base. The tank shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels, shall bear the Code stamp, and the exterior shall be primed and painted with the manufacturers standard process. The tank shall have all necessary openings for inlet, discharge, drain, and gauge piping connections. A drain pipe and shutoff valve shall be provided on the bottom of the tank.

Rubber-in-shear vibration isolators shall be provided for mounting the tank to a concrete base.

2.2.03 Accessories. The unit shall be factory furnished with a vacuum gauge and vacuum switches piped to the tank. Additional vacuum system valves and miscellaneous piping and accessories shall be provided by Contractor as indicated on the drawings.

2.2.04 Controls. The vacuum pump unit shall be provided with a factory wired and installed control panel. The panel shall be rated NEMA Type 1 and shall include motor starters, vacuum switches, alternator, transformer, "TEST-OFF-AUTO" selector switches for each pump, and motor overload reset pushbuttons. The motor starters shall be combination magnetic motor starters with a magnetic motor circuit protector. Overloads shall be matched to the motors. Vacuum switches shall have a cut-out range of 5 to 25 inches Hg (16.9 to 84.6 kPa), and an adjustable differential of 4 to 12 inches Hg (13.5 to 40.6 kPa). Vacuum switch contacts shall be rated for 10 amperes at 120 volts ac.

2.2.05 Sequence of Operation. When the selector switches are placed in the "AUTO" position, the vacuum switches and alternator shall control vacuum pump operation in a start-stop or lead-lag manner, as required.

For start-stop pumps, upon a decrease in vacuum, the pump shall be energized. When the "Pump OFF" vacuum setpoint is reached, the pump shall be de-energized. Initial vacuum switch setpoints shall be as indicated in the following list:

Pump "ON"	17 inches Hg (57.5 kPa)
Pump "OFF"	21 inches Hg (71.1 kPa)

For lead-lag pumps, upon a decrease in vacuum, the lead pump shall be energized. If the vacuum continues to decrease, the lag pump shall also be energized. The lead and lag pumps shall be alternated on each cycle. Initial vacuum switch setpoints shall be as indicated below:

Lead pump "ON"	17 inches Hg (57.5 kPa)
Lag pump "ON"	15 inches Hg (50.8 kPa)
Pumps "OFF"	21 inches Hg (71.1 kPa)

2.2.06 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.

2.2.07 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of the equipment by Owner. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

2.2.08 Equipment Bases. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection.

2.2.09 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.2.10 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.2.11 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.3 CLEANING AND ADJUSTING. Upon completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves, and fittings shall be thoroughly washed to remove grease, metal cuttings, and dirt particles. Any stoppage or other damage caused by Contractor's failure to clean the piping system properly shall be repaired by Contractor without additional cost to Owner.

End of Section

SECTION 15486

DISTILLED WATER SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers distilled water systems, including required equipment, piping, valves, fittings, gauges, bases, anchor bolts, and other accessories and appurtenances required for a complete unit. The equipment shall be installed in the laboratory as indicated on the drawings.

The distribution piping, recirculation piping, and isolating valves shall be in accordance with the piping and valve sections.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Power Supply. Except as otherwise specified, power supply to the equipment will be 480 volts, 60 Hz, 3 phase.

1.3 SUBMITTALS. Complete schematic and wiring diagrams, assembly and installation drawings, together with detailed specifications and data covering material used, power drive assembly, parts, devices, and other accessories forming a part of the equipment furnished, shall be submitted in accordance Master Specification Section 01080, Equipment, Project Submittals.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01060, Training and Operation & Maintenance Manuals.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 CONSTRUCTION. Each distilled water system shall consist of one pretreatment filter, one water still, one storage tank, one circulation/distribution pump, post treatment filters, piping, and accessories normally included as part of a laboratory distilled water system.

2.1.01 Water Still. The unit shall be a classic tin lined copper and bronze still with low water cutoff, double wall evaporator, vented condenser, and a vapor baffle for pyrogen removal. The water still shall produce 5 gallons per hour (5.3 ml/s) distilled water with a minimum resistivity of 3000 Ω-m and shall be Barnstead "Model A 1015-D", or approved equal. The still shall have a fully automatic control system with an adjustable drain timer cycler. Control system shall be Barnstead "Model G2110", or approved equal. The still shall be mounted on a floorstand in the location indicated on the drawings. The still shall operate on 240 volts, 60 Hz, single phase. The solid-state low water cutoff box shall be provided with a separate 120 volt supply. Solid-state low water cutoff box shall supply power to open and close both inlet and outlet solenoid valves, shall provide terminal connections for both valves, LWCO probe, direct acting level monitor, and contactor controls. Reverse acting level monitor shall be powered from the recirculation pump motor starter CPT. The motor starter shall be provided under Master Specification Section 16050, Electrical General Requirements. Contactor for still, solid-state LWCO box, direct and reverse acting level monitors, inlet and outlet solenoid valves, and LWCO probe shall be provided by equipment manufacturer.

2.1.02 Storage Tank. The storage tank shall be copper with tin coating, 100 gallon (379 L) capacity and shall be Barnstead "Model No. B3047", or approved equal. The tank shall be provided with gauge glass, removable cover, tin-coated, draw off faucet, water inlet connection, water outlet connection, drain, pump suction connection, water seal, recirculation return connection, high and low level monitors, "Model H4005" ultraviolet lamp, low water cutoff, and "Model H3111" vent guard. The ultraviolet lamp shall be the immersion type and shall fit inside a transparent inert sheath. The lamp shall be provided with 10 "Model O4141" replacement bulbs. The tank shall be mounted on a floorstand at the location indicated on the drawings. The floorstand shall be fabricated of steel angle iron and shall be Barnstead "Model No. H1003", or approved equal.

2.1.03 Distribution/Recirculation Pump. The distribution/recirculation pump shall be 1-1/2 hp (1.12 kW), 3,450 rpm, horizontal centrifugal and shall be Barnstead Size DD Pump, "Catalog No. H1140", or approved equal, less the bypass piping. The pump shall pump to the distribution line which shall be piped back to the storage tank from the end of the distribution circuit. Pump housing and all wetted parts shall be AISI type 316 stainless steel. The pump shall be sealed with a teflon gasket, Viton O-ring and a John Crane Type 21 Viton/carbon/ceramic mechanical seal, or approved equal. The pump shall operate on 460 volts ac, 60 Hz, 3 phase. The pump shall be driven by a heavy-duty, totally enclosed, split case induction motor with ball bearing shaft supports. Included leads shall be contained in a junction box for connection to the power supply and to a low water cutoff located on the storage tank. Motor starter shall be furnished under Master Specification Section 16050, Electrical General Requirements.

2.1.04 Post Filters. Analytical grade post filters shall be installed at the locations indicated on the drawings. Each filter shall have a remote above counter mounted microprocessor controlled purity monitor and a remote above counter dispenser and shall be Barnstead "Model D4741", or approved equal with a "Model D5025" Type 1 cartridge kit, or approved equal.

Bioresearch grade, pyrogen free, post filters shall be installed at the locations indicated on the drawings. Each filter shall have a remote, above-counter mounted microprocessor controlled purity monitor and a remote above counter dispenser and shall be Barnstead "Model D4751", or approved equal with a "Model D5025" Type 1 cartridge kit, or approved equal.

2.1.05 Accessories. All accessories and appurtenances required to complete the installation of the distilled water package including all pipe, fittings, valves, cocks, gauges, and other accessories and appurtenances required to provide a workable and satisfactory installation shall be as manufactured or as recommended by the Barnstead Company, or approved equal.

2.1.06 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors.

2.1.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.1.08 Shop Coating. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Field painting shall be indicated in Master Specification Section 09900, Painting.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of a universal primer.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.3 CLEANING AND ADJUSTING. Upon completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves, and fittings shall be thoroughly washed to remove grease, metal cuttings, and dirt particles.

End of Section

SECTION 15487

FUEL DISPENSING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installation of fuel dispensing systems an indicated in the Contract Documents.

The fuel shall be for use in service vehicles. The fuel dispensing system shall be furnished and installed in the location and arrangement indicated on the drawings and as required, complete with fuel dispensers and all other accessories necessary for a complete and properly operating installation.

1.2 GENERAL. All equipment for this section shall be furnished by or through a single manufacturer who shall be responsible for the design, coordination, and proper installation and operation of the entire system.

Equipment furnished under this section shall be fabricated and installed in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, materials, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Contractor shall properly coordinate the work between the Suppliers of equipment to be used with or connected to the storage tank to ensure that all required provisions for mounting the accessories are included.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service form other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representative shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to the equipment furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these Specifications and any state law or municipal ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories (UL) safety requirements.

Equipment furnished under this section shall comply with the applicable requirements of the following:

> ASTM A283 "Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars," or ASTM A569 "Steel, Carbon, Hot-Rolled Sheet and Strip, Commercial Quality."
>
> American Petroleum Institute.
>
> National Fire Protection Association.
>
> Applicable local regulations and ordinances.

1.2.03 Power Supply. Power supply to equipment with motors shall be as indicated on the Contract Documents. Power supply for controls shall be as required, unless otherwise required for a properly operating system.

1.2.05 Labels. Each dispenser shall have a conspicuous, easy-to read label showing the manufacturer's name and the rated capacity.

1.2.06 Metal Thickness. Gages specified herein refer to US Standard gage.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete fabrication, assembly, and installation drawings, together with detailed specifications and data covering materials used, parts, devices, and other accessories forming a part of the tank and fuel dispensing facilities furnished, shall be submitted in accordance withMaster Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable.

Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of each electrically operated motor driven pump, and complete details and information on the power feed system.

The data shall also indicate the sizes of all major components and full information and details concerning field assembly and installation.

The manufacturer's standard calibration charts shall be submitted.

1.3.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in Master Specification Section 01060, Training, Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

1.4.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.4.02 Contractor's Qualification. When indicated on the Contract Documents, Contractor shall submit qualifications to do the work.

1.5 DELIVERY, STORAGE, AND HANDLING. Shipping ,handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

The tank and component parts shall be adequately protected during all transportation, loading and unloading, storage, installation, and subsequent construction activities. All nozzles shall be properly protected at all times and shall be plugged to prevent contamination of the tank interior. Repairs of minor damage, including scratches and abrasions, may be made where permitted by the Engineer in the manner recommended by the manufacturer. If a tank is damaged beyond reasonable repair, in the opinion of Engineer, it will be rejected and shall be replaced by Contractor with an undamaged unit.

At no time shall a tank be dropped or rolled. All lifting shall be done using the lifting lugs or suitable slings.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The fuel dispensing system shall be suitable for the conditions specified and the locations indicated on the drawings.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The fuel dispensing system shall be designed to supply diesel fuel or unleaded gasoline, as indicated, for refueling vehicles. The system shall be designed as a one or two hose, one or two product, as indicated in the Contract Documents.

2.3 FUEL DISPENSER. The dispenser shall be of the number of hose and product as indicated. Registers shall read on the front of dispenser with 99.9 gallon delivery register and 99,999.9 gallon nonreset totalizer. Meters shall be neutating disc-type with a calibration screw. The dispenser shall be equipped with strainer, replaceable cartridge filter, pump, electrical junction box, 1-1/2 inch suction, float chamber to prevent meter register from operating when tank is empty, and shall bear UL listing. Cabinet finish shall be baked red enamel. The pumped product shall be identified by means of a decal, painted sign, or other label. The dispenser shall be as manufactured by Fill-Rite or approved equal.

All nozzles shall be shockproof, self-closing and automatic type permitting at least three positions of the hold-open clip and shall meet all requirements required by the U.S. Environmental Protection Agency. All hose shall be 1 inch diameter, 12 feet in length, and shall be suitable for direct sunlight and air temperatures up to 100 F. Hose retrieving devices and swivels shall be installed with all hoses.

Pulsers and detect wires shall be factor installed for each hose in each dispenser, suitable to the fuel management system control console.

Fuel dispensers shall be factory wired such that they require only the specified power supply for proper operation.

2.4 FUEL DISPENSER ACCESSORIES. The accessories for each fuel dispenser shall be provided as indicated on the drawings and specified herein.

2.4.01 Pressure Regulating Valves. The inlet pipe on each dispenser shall be equipped with a 1-1/2 inch pressure regulator valve, Tokheim "Model 52", or approved equal. The pressure regulator valve shall be mounted so that the valve and inlet piping are rigidly set in position and shall be furnished with a safety shear section.

2.5 Fuel Management System. A cardless, keyless fuel management system shall be provided, installed, and placed in roper working order. Fuel management system shall be as manufactured by Fill-Rite or approved equal, shall be compatible with the dispensers provided, and with suitable relay for the pump motor. The system shall feature two wire communication, vehicle identification number entry keypad, and data retrieval by remote printer readout.

Fuel management system shall be ETL listed and consist of all items required for proper operation as specified and shall meet all local, state, and national code requirements.

The system shall provide control and access to each fueling dispenser and to store and print out, upon demand, specified data relevant to the fueling transaction. Access to the system shall be through the weatherproof terminal keypad. The terminal shall be mounted on a contractor-supplied pedestal with all required junction boxes and terminal connection clearly marked with correct wiring identification. The fuel management system supplier shall provide all wiring between the fuel management system and fuel dispensers.

The fuel management system shall control all dispensers, each with number of hoses as indicated. User access to obtain fuel shall be gained once the vehicle identification number has been manually entered onto the terminal keypad. The terminal keypad shall also incorporate battery backup to retain information in memory, in the event of a power failure or system shutoff, display operating instructions, and an RS485 port with converter cable for data retrieval.

The fuel management system shall not permit additional fueling transactions once the memory is full. The fuel management system shall be suitable for future upgrading for fleet management to be 100 percent compatible with IBM personal computer.

A parallel port Epson "Model LX300", or approved equal shall be provided to provide a hard copy audit trail of the transactions. The printer shall be located in the building. Sufficient length of interconnecting cable shall be provided to connect the terminal keypad to the printer.

Print out of the fueling transactions shall include, but not to be limited to the following items:

Vehicle Identification Number.

Transaction Termination Code.

Transaction Date.

Transaction Time.

Hose Number.

Total Volume dispensed.

Pulsers and detect wires shall be provided on dispensers. Conduits shall be provided for power and detect wires. Pulser lines may not be run in the same conduit as power lines.

System manufacturer shall warrant the system against defective materials or workmanship for two years from date of startup by factory trained personnel.

Contractor shall provide system startup and operator instruction by factory trained personnel for one day after notification that the system is in pace and ready to operate at no charge to Owner.

System to include locking emergency stop switch shall be provided to shut of the power to the dispensers in the event of an emergency.

2.6 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

PART 3 - EXECUTION

3.1 INSTALLATION. Each dispenser and accessories shall be installed in accordance with the manufacturer's instructions, specifications, and drawings.

Each dispenser and accessories shall be installed on a concrete base as indicated on the drawings.

Each dispenser shall be mounted securely on a steel pump spill containment box cast in the concrete base. The pump spill containment box shall be provided with opining and an adjustable shear clamp for the inlet pipe. The pump box shall be AMFAB, shall be suitable for the dispenser, and shall be of ample size to contain spillage when maintenance is required on the pump and for piping and electrical connections.

Fuel management system terminal shall be mounted on templates with all conduits running inside template and terminal mounting pole.

3.2 INSTALLATION CHECK. An experienced, competent, and authorized representative of the manufacturer shall visit the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting appurtenances; and has been operated under full load conditions and that it operated satisfactorily.

3.3 FIELD TESTING. All testing required by governing standards shall be performed.

End of Section

SECTION 15490

HVAC GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE. These Sections and Drawings cover(s) the general requirements of the HVAC work to be performed and shall not void any of the requirements specified under the General Conditions or General Requirements.

Heating Equipment

Flue Stacks, Breechings and Vents

Air Handling Units

Centrifugal Fans

Ductwork and Accessories

Electric Automatic Temperature Control System

HVAC Systems Testing, Adjusting and Balancing

The requirements specified herein shall be modified only if specified otherwise for a particular application in other Divisions. Work to be included under the "Scope of Work" of each HVAC Section listed above shall include all labor, material, equipment, tools and services necessary to furnish, deliver, unload, install, test and place in satisfactory operation the equipment, services and systems as called for under each HVAC Section including any incidental work not shown, or not specified but which can reasonably be inferred as belonging to the various systems and necessary in good practice to provide a complete and satisfactory operating system.

This HVAC specification is incomplete without the information contained on the Drawings and in the Schedules.

Description of the work included in each Section is not intended to in any way limit the above broad statement, but is intended as a more specific mention of the most important items included therein.

Without limiting the scope of work as shown on the Drawings and required in this Section the following specific mention of items of included work is made.

The scope of work shall include: fans, air handlers, make up air units, air-conditioning units, roof mounted units, duct work by material, thermal insulation by system, acoustical insulation by system, piping by system, sting and balancing, space heaters, ductwork accessories, louvers and dampers, automatic controls by type. In addition any item that could be considered unusual shall be included.

The contractor shall coordinate with the equipment manufacturers control and field installation items furnished. The contractor shall field install and wire furnished loose by the equipment manufacturer.

All ductwork, piping, and equipment shown on the Drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The Contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.2 RELATED REQUIREMENTS. Cutting coving and patching, except for items specified herein, is included in Division 1. Temporary heating, electric power and lighting is included in Division 1. Trenching, excavation and backfill except for items specified herein, is included in Division 2. Concrete work except for furnishing of required anchor bolts, sleeves and templates, which shall be furnished with equipment, is included in Division 3. Flashing and counter flashing, except for items specified herein is included in Division 7. Painting except for factory finished equipment, shop painting and identification labeling is included in Division 9. Miscellaneous metal for supplementary steel required for hangers, equipment supports, anchors and guides, which shall be furnished with equipment, is included in Division 15. Exterior louvers including installations are included in Division 10. Plumbing except water and drains in connections to HVAC equipment is included in other Sections of this Division. Electrical field power wiring except for field wiring for automatic temperature controls as specified and as shown on the HVAC Drawings is included in Division 16.

1.3 SUBMITTALS. Submit, in accordance with Section 01080, all shop drawings specified in the individual Sections. Submittals shall include the following:

Catalog data for all motors to include operating efficiency.

Catalog data on vibration isolator, including operating efficiency and layout diagram that locate the isolates on the equipment by model number. Catalog data on bearings and confirmation of bearing life for the service specified.
Information on coatings as specified in the coating section.

Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit

All submittals shall contain a statement that Section 15501 and all other referenced Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

1.3.01 <u>Operation and Maintenance Data and Manuals</u>. Submit to the Engineer as provided in Section 01160, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

Contents - Each volume shall contain the following minimum contents:

Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual. Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.

Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

1.4 REFERENCE STANDARDS. The latest published issue of Standards or Recommendations of the following listed Societies, Associations or Institutes in effect 3 months prior to the date of this Contract are part of this Section. These shall be considered as minimum requirements. Specific requirements of this Section and/or Drawings shall have precedence. In case of conflict between published requirements, the Engineer shall determine which is to be followed.

Abbreviation and the title of Federal, State and industry standards, technical societies, associations and institutes and other organizations used are as follows:

AABC - Associated Air Balance Council

ACGIH - American Conference of Governmental Industrial Hygienists

ADC - Air Diffusion Council

ABMA - American Bearing Manufacturers Association

AMCA - Air Movement and Control Association ANSI - American National Standards Institute ARI - Air-Conditioning and Refrigeration Institute
ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASME - American Society of Mechanical Engineers

ASTM - American Society for Testing and Materials

CTI - Cooling Tower Institute

FM - Factory Mutual Engineering and Research Corp. IBR - Institute of Boiler and Radiator Manufacturers
1IEEE - Institute of Electrical and Electronics Engineers NIST - National Institute of Standards and Technology NEBB - National Environmental Balancing Bureau
NEC - National Electrical Code

NEMA - National Electrical Manufacturers Association

NFPA - National Fire Protection Association

OSHA - Occupational Safety and Health Administration

SMACNA - Sheet Metal and Air Conditioning Contractors National Association

UL - Underwriters Laboratories

1.5 QUALITY ASSURANCE. All equipment of a given type included in this Section shall be furnished by or through a single manufacturer or as specified on the schedules
Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents.

1.6 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

Instructions for the servicing and startup of equipment in long term or prolonged storage shall accompany each item.

All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.7 DEFINITIONS. Particular terminology used under this Division is defined as follows: Air Conditioning - Environmental control of temperature, humidity, cleanliness and air circulation, including the cooling of an enclosed space.

Air Conditioner or Air Conditioning Unit – One or more field-erected or factory-made assemblies, which includes the refrigeration compressor-condenser assembly, for the handling and control of air temperature, humidity, and cleanliness used for cooling.

Fan-Unit - Any unit or assembly containing a fan, motor and drive.

Temperature Controller - Any device which is used to modulate the automatic temperature control system by a change in temperature at the location of the controller.

Explosion Proof - Any equipment or device, which is called to be explosion proof, shall be certified as explosion proof as a complete unit.

1.8 COORDINATION. The Drawings indicate the extent and general arrangement of the systems. If any departures from the Drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer. The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer. The Contractor shall assume full responsibility for coordination of the HVAC systems, including; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

1.9 ENGINEERING SERVICES. When engineering services are specified to be provided by the Contractor, the Contractor shall retain a licensed professional engineer to perform the services. The engineer shall be licensed at the time the work is done and in the State in which the project is located. If the State issues discipline specific licenses, the engineer shall be licensed in the applicable discipline. In addition, the engineer shall be experienced in the type of work being provided.

All work is to be done according to the applicable regulations for professional engineers, to include signing, sealing and dating documents. When submittals are required by a professional engineer, in addition to state required signing and sealing, a copy of the current wallet card or wall certificate indicating the date of expiration shall be included with the submittal.

1.10 ELECTRIC MOTORS. Electric motors in NEMA frame sizes shall conform to the requirements in Section 16150, unless otherwise specified herein.

Clean Dry Areas ODP

Outdoors TEFC

Process Areas

NOT Div. 1 or 2 TEFC

Div. 1 or 2 Explosion Proof.

The motor manufacturer shall confirm that motors used to power equipment are provided with bearings that will provide a bearing life equal to the driven equipment or better. Confirmation shall be included with shop drawing submittal.
Motors will be selected to be non-overloading over the entire operating range of the equipment. A safety factor of 25 percent will be added to all motors up to and including 50 horsepower. A safety factor of 15 percent will be added to all motors over 50 horsepower. Motors indicated in the schedules are to be considered a minimum. The schedule sizing is not to limit compliance with the above requirements.

1.11 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts In addition to special items, the following spare parts shall be provided:

> Furnish all special tools required for normal operation and proper servicing of the equipment.
>
> Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:
>
> One complete set of drive belts for each piece of belt driven equipment
>
> Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers.

Spare parts shall meet the requirements of Sections 01180.

1.12 WARRANTY. In the event that the equipment or components fail to perform satisfactorily at any time within the Defects Liability Period, the Contractor shall replace it with one capable of operating as specified, and shall comply with the requirements in Division 1. The Contractor shall be responsible for all cost incurred in furnishing and installing the replacement equipment.

PART 2 - PRODUCTS

2.1 ELECTRICAL EQUIPMENT. Certain items of electrical equipment which are furnished under this Section shall meet the requirements specified in Division 16:

Disconnect switches, motor starters and combination motor starters (starters with disconnecting means and short circuit protection) shall be as specified in Section 16050.

Cord-connected controls for hazardous areas shall be provided with intrinsically safe relays, which shall be as specified in Section 16050.

Raceways, boxes and fittings shall be as specified in Section 16050. Wires and cables shall be as specified in Section 16050.
Electrical enclosures and panels, to include automatic temperature control panels and components shall be suitable for the environment and electrical classification for the space they are located in. The type of enclosure for the various spaces shall be as specified in Division 16. Refer to the electrical drawings for the space classifications.

Where location designations are not shown on the HVAC Drawings refer to the Electrical Drawings

2.2 EQUIPMENT VIBRATION ISOLATORS AND MOUNTINGS. Unless otherwise specified in this Division all machinery or vibrating mechanical equipment shall be isolated from the building structure by vibration isolators with a minimum deflection as specified. Operating equipment that can transmit objectionable vibration and noise must be installed with special types of vibration isolators such as flexible connectors to ductwork, piping and wiring. In more critical areas and under particular conditions, additional vibration isolators shall be installed as specified in other related Sections in this Division, or in specific equipment schedules.

All equipment shall be provided with attachment points for floor or suspended mounting that will safely transmit all loads to the supports.

The vibration isolator manufacturer shall be responsible for the proper selection of vibration isolators suitable for the particular application. Selection of the vibration isolator shall include the following factors:

Equipment Weight

Equipment operating frequencies

Type of building support structure

Vibration isolators shall be furnished with the equipment.

All floor mounted vibration isolators shall be bolted to the floor or framing on which they rest. Bolts shall be arranged to prevent transmission of vibration through the bolts.
All isolation devices for a single piece of equipment shall be selected for a uniform static deflection according to distribution of weight in the equipment.

All pieces of equipment that have a variation in weight during operation or maintenance such as, but not limited to, cooling towers and hoppers, shall have built-in vertical limit restraints to limit motion to a maximum of 1/4-in.

Isolators exposed to the weather, in rooms classified on electrical drawings as damp, wet, or corrosive or where called for on the Drawings shall be provided with corrosion protection. Steel parts other than springs shall be galvanized. Parts subject to wear, rubbing, shall be non-corrosive material such as rubber or stainless steel. Springs and hardware shall be cadmium plated or otherwise provided with an approved coating.

After installation of equipment, isolators shall be adjusted for proper loading and distribution of weight.

Types - The following types of vibration isolators may be used.

Isolation Types for Floor Mounting

Single elastomer-in-shear isolators, molded mound shaped element designed for 1/4-in deflection under the imposed static load. Double elastomer-in-shear isolators shall be two such elements assembled in series or a molded element designed to provide 1/2-in deflection under the imposed static load. Elastomer-in-shear isolators shall be properly housed to prevent bulging and shall be provided with adequate facilities for bolting to equipment and floor slab.

Spring isolators shall be free standing and laterally stable and shall be equipped with acoustical-friction pads, leveling bolts and bolt holes for anchoring to floor slab. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection. Where housed springs are specified or required, provide units with telescoping cast iron or steel housing, containing one or more springs, complete with resilient alignment insert and a minimum of 1/4-in thick rubber or neoprene sound deadening pad bonded to the base of housing.

Heavy load pads shall be 1-1/4-in thick and shall consist of a high load capacity elastomer pad and sandwiched between two 1/8-in thick steel load distribution plates capable of supporting loads up to 250 psi. For large pad area, steel plates of suitable thickness shall be provided to distribute the load.

Light load pads shall be neoprene corrugated single, laminated double or laminated with 1/2-in thick fine granular composition cork sandwiched between two 1/4-in layers of corrugated, oil resistant neoprene. Pads shall be capable of loading to 50 psi.

Isolation for Suspension

Isolation hangers for suspension of equipment and piping shall have a single element of elastomer for 1/4-in deflection, a double or a single molded element of 1/2-in deflection, a single spring element with an elastomer grommet for up to 3/4-in deflection and a combination of an elastomer and spring elements in series for 1-in deflection and up contained within a structural rigid one piece steel hanger box. Springs shall have a minimum ratio of outside diameter to operating spring height of 0.8 and an additional travel to solid equal to 50 percent of the specified deflection.

The neoprene element shall have a bushing to prevent hanger rod contact with the housing box. The lower rod shall be free to swing in a 30 degree arc without touching the spring or the housing.

Rails and Bases - Rails and bases shall be of the following types based on the equipment and deflection required.

Rubber in shear type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall incorporate single or double deflection elastomer-in-shear fastened in place and a continuous steel floor bearing plate running the full length of each rail. The rails shall be drilled and tapped to accept the supported equipment and shall serve as a template.

Steel spring type shall be steel rails running the full length of the supported equipment and extending under any overhang to counteract cantilever effects. The rails shall consist of structural members supported by individual free standing springs. The rails shall be drilled to accept the supported equipment and shall serve as a template.

Fans and their driving motors shall be mounted on structural steel channel members forming a rigid base. A common member, parallel to the V-belt drive, shall run the full length of the fan and motor and shall be of sufficient rigidity to resist the bending stress of belt pull. The structural steel base shall incorporate single or double deflection elastomer-in-shear elements or free standing springs located for proper weight distribution. The base shall be drilled and tapped to accept the fan and motor and shall serve as a template. Integral motor slide rails shall be provided and welded in place.

Unless specifically noted in other Sections or on specific equipment schedules, all equipment will be provided with vibration isolation as defined by the following table:

Type of Equipment	Vibration Isolation Type	Minimum Deflection for Slab on Grade Inches	Minimum Deflection for up to 20-ft floor span inches	Minimum Deflection for 20-ft to 30-ft Floor Span Inches	Minimum Deflection for 30-ft to 40-ft Floor Span Inches
Axial & Cabinet Fans					
22-in dia. and less	Rubber	0.25	--	--	--
22-in dia. and less	Spring	--	0.75	0.75	0.75
Over 22-in dia. Over 2-in S.P.	Spring	0.75	1.75	1.75	2.50

Type of Equipment	Vibration Isolation Type	Minimum Deflection for Slab on Grade Inches	Minimum Deflection for up to 20-ft floor span inches	Minimum Deflection for 20-ft to 30-ft Floor Span Inches	Minimum Deflectio n for 30-ft to 40-ft Floor Span Inches
Centrifugal Fan					
22-in dia. and less	Rubber	0.25	--	--	--
22-in dia. and less	Spring	--	0.75	0.75	1.75
24-in dia. and greater					
40 HP and less	Spring	0.75	0.75	0.75	1.75
50 HP and greater	Spring	1.00	1.75	1.75	2.50
Condensing Units					
	Rubber	0.25	--	--	--

	Spring	--	0.75	1.75	1.75
Air Handling Units					
10 HP and less	Spring	0.75	0.75	0.75	0.75
15 HP and greater	Spring	0.75	1.75	1.75	1.75

Isolation for Piping

Flexible piping for systems with operating temperatures over 200 degrees F shall be flexible annular corrugated stainless steel hose. The hose shall be provided with an external stainless steel braid to minimize elongation under pressure. Hoses 2-1/2-in and smaller shall be threaded and hoses 3-in and larger shall be flanged. The manufacturer shall confirm the suitability of the flexible piping for the temperature and pressure of the systems.

Flexible piping for systems with operating temperatures 200 degrees F and less shall be spherical EPDM connections. Connections shall have multiple plies of corded fabric reinforcing. Connection shall be rated for 150 psi at 220 degrees F. For equipment with connections from 2-1/2 to 12-in, 90 degree bend connections can be used. Straight connections shall be double sphere and bend connections shall be single sphere. Provide control cables to prevent excessive elongation on straight connection where required. The manufacturer shall confirm the suitability of the connections for the temperature, pressure, and pipe contents for the systems.

Rigidly Mounted Equipment

When equipment doesn't require vibration isolation, it shall be firmly attached to the building structure. Bolts and support structure shall include allowances for seismic loads as required by the applicable building codes to include shear and moment loads.

2.3 BEARINGS. Grease lubricated bearings (except where driven by motors smaller than 1/2 Hp) shall be equipped with Zerk lubrication fittings and with provision for automatic relief of lubricant pressure away from fan wheel or pump seal. The latter may be accomplished by either built-in relief devices or automatic ball-and-spring relief fittings at the bottom of the bearing housing.

Pressure relieves shall be located outside of the units and shall be visible from maintenance locations. Lubrication fittings shall be located to be easily accessible from maintenance or operating levels. Where necessary, extension tubes shall be provided to bring the service fitting to an accessible location and the relief visible from the same location.

Bearings for all equipment in the schedule below shall have heavy-duty grease lubricated ball or roller bearings. Bearings shall have ample thrust provision to prevent end play during the normal life of the bearing. Unless specifically noted otherwise, all fans and pumps shall have bearings for both the equipment and motors with the following ABMA L-10 life.

Fans over 3000 cfm – 40,000 hours.

Continuous duty fans with motors over 25 horse power 100,000 hours.

For systems with bearings requiring L-10 lives of 100,000 hours or greater, the equipment supplier shall provide calculations for both the equipment bearings and the motor bearings to confirm the bearing selections. For belt drives, the calculations shall include the effect of the sheave size, number of belts, the sheave location on the shaft, and the location of the motor to the driven sheave.

The equipment manufacturer shall provide confirmation of the required life based on the actual drive components. For motors 50 horsepower and greater, the bearing life calculations for both the equipment bearings and the motor bearings shall be provided.

2.4 <u>FLAME AND SMOKE RATINGS</u>. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the Federal Standard 00136B, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA.

These requirements shall apply to all circumstances whether the materials are field applied or have been applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project for installation.

2.5 <u>V-BELT DRIVE</u>. V-belt drives shall consist of the driver and driven sheaves and one or multiple matched V-belts. Drives furnished to transmit less than 3/4 Hp may be a single groove, single belt type. Drives to transmit 3/4 Hp or more shall consist of at least two belts. Belts smaller than "A" cross-section shall not be used.

Each sheave shall be grooved to match the belt selection, bored and keyed to fit the receiving shaft, and grooves shall be in parallel planes exactly perpendicular to the bore for the full 360 degrees. Sheaves shall have keys and setscrews. Sheave material may be cast iron.

The drive shall be sized 1.5 times the motor nameplate rating and also shall have ample strength to start the driven equipment by full voltage across-the-line motor starting.

Where variable speed drive is specified, the drive sheave shall be of the variable pitch type which will provide a 5 percent speed variation of the driven equipment at the nominal rated speed. However, the higher speed side shall not cause the driven equipment to draw more than full nameplate rating horsepower from the driver.

2.6 NOISE CRITERIA. The selection of fans, air handling equipment, air conditioners, heating ventilating and air conditioning machinery and mechanical equipment and the installation of the system components such as duct work and piping shall be such as not to exceed to maximum permissible noise for non-equipment spaces as defined in Table 2, Design Guidelines for HVAC System Noise in Unoccupied Spaces contained in the 2003 edition of the ASHRAE Application Handbook. Under no conditions shall the noise created by equipment exceed the levels of permissible noise exposures of occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances.

The equipment supplier shall provide actual data for the equipment submitted. If the space does not meet the required criteria, and the noise level of the equipment is found to be the cause, the equipment supplier shall be responsible for the modifications required to correct the condition.

PART 3 – EXECUTION

3.1 INSTALLATION. The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

3.2 CLEANING AND DISINFECTION. All piping, ductwork and equipment shall be left in a thoroughly cleaned condition. All piping shall be thoroughly flushed to remove all foreign materials prior to any cleaning procedure. All strainer baskets shall be removed, cleaned and reinstalled at the completion of the cleaning operation and also at the completion of all system and equipment final tests. All flushing and cleaning shall be to the satisfaction of the Engineer. Furnish, install and remove all temporary piping and equipment used in the cleaning and flushing operations. Cleaning and flushing shall be performed as specified in other Sections.

3.3 TESTS AND BALANCING. General - Balance and test all systems. Test the work as required by the Engineer during the progress of the work to demonstrate the strength durability and fitness of the installation. Furnish all instruments, ladders, lubricants, test equipment and personnel required for the tests; including manufacturer's representatives for testing and start-up of all supplied equipment.

Balancing and testing shall be performed as specified in other Sections. Before testing and balancing, all systems shall be cleaned and disinfected as specified. Four copies of records of all tests, measurements, settings of throttling devices and nameplate data shall be presented to the Engineer.

Final Tests - Tests of all systems shall be carried out as required by the Engineer prior to final acceptance of the systems for the purpose of demonstrating satisfactory functional and operating efficiency as well as adjustment. During this period, the setting of all automatic controls shall be checked and sufficient measurements taken to ensure that conditions are correct and that capacities are adequate to meet the specified requirements. Provide competent personnel to conduct all tests. Systems will not be considered complete until all tests have been concluded to the satisfaction of the Engineer and all other parties having jurisdiction. In event of leakage or defects, tests must be repeated until all faults are corrected. All tests shall be performed in the presence of the Engineer. The general operating tests shall be performed under as near design conditions as possible.

Testing and balancing of all heating, ventilating and air conditioning air and water systems shall be performed by an AABC or NEBB certified agency, which is independent of all suppliers and installers on the particular job. All testing, adjusting and balancing shall be done under the supervision of a qualified heating, ventilating, and air conditioning Engineer employed by the air balance and testing agency. Reporting forms for testing and balancing shall be as recommended by the AABC or the NEBB.

3.4 START-UP AND TEMPORARY OPERATION. Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner.

This maintenance shall include compliance with the manufacturers operating and maintenance instructions as well as periodic checking and cleaning of the strainers and filters and the lubrication of moving parts and all required adjustments.

Records of all maintenance and lubrication work performed on Owner or Contractor furnished equipment shall be maintained at the construction or installation site and shall be available at all times for a review by the Owner or Engineer. At the request of the Owner or Engineer copies of these records shall be submitted to the Owner for information and/or review.

3.5 PAINTING AND COATINGS. Unless otherwise specified, all machinery and factory finished equipment such as fans, air handling units, air conditioning units, and other items of manufacture shall be hot dipped galvanized or will have a factory applied finish, color as standard with the manufacturer. Components fabricated from stainless steel do not require a coating finish unless otherwise specified. All tanks, supporting steel, hangers, rods and all other uncoated or non-galvanized steel other than standard piping and fittings shall have a shop coat consisting of a suitable primer and finish coat. If not factory applied, the prime coat shall be as specified in Division 9. All items not factory or shop primed prior to installation shall be suitably cleaned of rust and mill scale by wire brushing, sanding, or other means and prime painted, immediately after installation.

The Contractor shall be responsible for the repair of all defects, blemishes, holidays and the like apparent in manufactures coatings and shall ensure that the materials used for such repair shall match and be compatible with the manufacturer's standard color, coatings and practices. Surfaces to be repaired or recoated are to be prepared as recommended by the paint or coating supplier. Care shall be taken not to paint over nameplates.

Furnish touch up paint for the various types of equipment furnished and deliver unopened paint to the Owner at completion of the project. The amount of touch-up paint supplied shall be sufficient to cover 15 percent of the applicable painted surfaces or one pint, whichever is greater.

Where specified, or called for on the following schedule, special corrosion resistant/protective coatings shall be provided. Whenever a protective coating is specified, the equipment shall be coated both inside and out. Whenever necessary to provide full coverage of the equipment, the equipment shall be completely disassembled to allow proper preparation and coating application. Any component that would block the coating process shall be removed. Equipment provided with gaskets or liners shall be coated before the application of the gasketing or liner. The equipment Vendor shall test rotating equipment after coating to confirm dynamic balance. If work needs to be done to correct the equipment balance, the integrity of the coating must be corrected after such work.

Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.

All items to be provided with a protective coating shall have the following data on the coating included with the unit submittal. Submittal shall include vendor data sheets on the specific coating being used, corrosion resistance data sheets, detailed application data sheets to include surface preparation procedures. For baked coatings submit a letter from the coating manufacturer, that the company doing the actual coating operation is an approved coating company. When an equipment supplier provides the coating, the information shall be supplied by the coating manufacturers.

Coating shall be factory applied by the equipment manufacturer/supplier. If this is not possible, coating shall be applied by a specialty shop under contract to the equipment manufacturer/ supplier. After coating application is completed, the equipment manufacturer/supplier shall test the equipment and certify system operation prior to releasing the equipment to the job site.

Any holidays, runs, sags, blisters, or inclusions in the coating are unacceptable and will be corrected. With the approval of the Engineer, small areas no more than 4-in by 4-in may be corrected in the field. Larger faults shall be returned to the coater to be repaired. The faulty material shall be removed by sanding and in the case of blisters, the edges feathered. The material used for recoating shall be manufactured by the same manufacturer as the original coating and shall be suitable for field repairs. The touch up material shall have the same corrosion resistance as the original coating, and if the original coating required an ultraviolet protection, the same protection will be provided as part of the repair. The final mil thickness of the repaired coating shall be equal to the originally specified thickness. Where baked coatings have been damaged, the repair shall be made with heat applied to the repaired surface to cure the coating. After curing a solvent test as recommended by the manufacturer shall be used to confirm that the coating is cured.

3.6 BALANCE OF ROTATING EQUIPMENT. All machines shall be balanced both statically and dynamically by the manufacturer within the limits of best commercial practices. The term machine, as used above, is to be considered as any piece of equipment which contains rotating components. All machines furnished shall have operating speed not exceeding 80 percent of the first critical speed.

End of Section

SECTION 15500

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heating, ventilating, and air conditioning (HVAC) equipment, coils, fans, ductwork, duct mounted devices, and appurtenances associated with the HVAC systems.

Schedules on drawings and notes indicate specific HVAC equipment required for the project.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, unless otherwise indicated on the drawings.

Capacity ratings for packaged air conditioning units and packaged heat pumps with capacities less than 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 210/240. For packaged air conditioning units over 135,000 BTUH (39 kW) the capacity ratings shall be in accordance with ARI Standard 360. Capacity ratings for packaged heat pumps with capacities over 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 340.

Flue piping and fittings shall be factory built, laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211.

Electric heating coils shall comply with the current National Electrical Code.

Direct fired makeup air units shall be independently certified to meet ANSI Z83.4.

Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the drawings, and shall be UL listed.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, ductwork, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/4 inch (19mm) high for section identity and 1/8 inch (3 mm) high for other information Nameplates and tags shall be at least 12 gage (2.66 mm) thickness. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.3.05 Ductwork. As required, ductwork shall be identified with nameplates as specified herein, or stenciled painting as specified in Master Specification Section 09900, Painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Packaged Air Conditioning Units/Packaged Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Makeup Air Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Burner or heating coil capacities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Fans

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Schematic control wiring diagrams showing multiline wiring for the unit and all interconnecting devices. Wiring diagrams shall be detailed to the degree required for field construction, with all terminals identified.

Equipment

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Sheet Metal Fabrication Drawings

Duct layout drawings indicating shop fabricated sections and dimensions.

Pressure and seal classifications.

Access panel and door construction, sizes, and locations.

Duct sealant, adhesive, gasket, and tape information.

Coatings.

Ductwork materials.

Coatings

Name of manufacturer.

Coating type.

Chemical resistance data.

Temperature range data.

Surface preparation and application data.

Film thickness per coat.

Drying and curing time.

Color.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower (kW) rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

Temperature Controls

Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the drawings.

Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring and instrument piping with all terminals and ports accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

Control valve schedule with each valve identified by the designations used herein and on the drawings and cross-referenced to the manufacturer's equipment data sheet or bulletin. The schedule shall also list complete sizing data for each valve, giving design flow and temperature or pressure, actual pressure drop, normal position, fluid, actual close-off rating, actual capacity index, and any other pertinent data.

Sequence of operation for each system corresponding to the control schematics.

Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

Space thermostat schedule indicating the types of covers and means of adjustment for each space.

Conduit and wire types.

<u>Number Plates</u>

A listing of equipment to receive number plates.

1.4.02 <u>Operation and Maintenance Data and Manuals</u>. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4.03 Samples. Samples of protective coatings for equipment shall be submitted to Engineer for approval. The samples shall be at least 3 inches by 3 inches (75mm by 75mm) in size, and shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. Extra materials for one complete change of lubricating oil and two sets of filters shall be furnished for the equipment.

Extra materials shall be packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as required.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be indicated in Master Specification Section 09900, Painting.

Machined, polished and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.08 Flue Systems. Flues shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Flue system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions.

2.4.08.01 Factory Built Flues. Flue systems for gravity vented equipment and vertically vented unit heaters listed for use with "Type B" gas vents shall be Selkirk Metalbestos, "Type B" gas vents, Metal-Fab, or approved equal. The flue systems for power vented equipment shall be Selkirk Metalbestos "Type PS" gas vent, Metal-Fab "Model PIC", or approved equal.

The flue pipe and fittings for vertically power vented unit heaters requiring a 5 inch (125 mm) or smaller flue and gravity vented equipment shall be a "Type B" gas vent. The flue shall be of double wall construction, with a 0.25 inch (6 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch (0.3 mm) aluminum and the outer jacket of at least 0.018 inch (0.5 mm) galvanized steel. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

The flue pipe and fittings for power vented equipment and power vented unit heaters requiring a 6 inch (150 mm) or larger flue shall be of double wall construction with a nominal 1 inch (25 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch (0.9 mm) AISI Type 304 or Type 316 stainless steel, as required, and the outer jacket of at least 0.025 inch (0.6 mm) aluminum coated steel for interior locations and Type 304 or AISI Type 316 stainless steel, as required, for the portions of the stack exposed to the outdoor environment. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

2.4.08.02 Metal Flues. The flue pipe and fittings for horizontally power vented unit heaters requiring a 5 inch (125 mm) or smaller flue shall be constructed of at least 24 gage (0.61 mm) thickness galvanized steel and shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The flue system shall include all necessary fittings, hangers, supports, and flashings.

2.4.09 Packaged Air Conditioning /Heat Pump Units. Packaged air conditioning units, denoted by the symbol "PAC" and an identifying number, and packaged heat pumps denoted by the symbol "PHP" and an identifying number shall be furnished and installed where indicated on the drawings. Each unit shall be designed for outdoor installation on a full perimeter curb or equipment pad as indicated on the drawings. The packaged air conditioning unit shall be manufactured by Trane, Carrier, McQuay, York, or approved equal.

2.4.09.01 Performance and Design Requirements. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with Refrigerant-22 and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated. The unit shall be suitable for the power supply and shall have the capacities indicated on the drawings.

The refrigeration system shall be capable of satisfactory operation at outdoor ambient air temperatures of 50°F (10°C) in the cooling mode and for heat pumps, 0°F (-18°C) in the heating mode. When the system must operate in the cooling mode at a lower temperature than the factory standard, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F (-18°C) consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

2.4.09.02 Casing. The unit casing shall be of weatherproof design and shall be constructed of 20 gage (0.91 mm) or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have one inch (25mm) thick, one pound (454 kg) density, insulation coated on the air side. Aluminum foil-faced glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed access doors or removable panels shall be provided to permit easy inspection and maintenance. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

Where an economizer package is not specified, a manually set air damper shall be furnished to provide the indicated outside air volume.

2.4.09.03 Indoor Coil Section. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig (1380 kPa gauge). The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions.

2.4.09.04 Heating Sections. When indicated on the drawings, the unit shall have an electric heating coil, gas heating section, or auxiliary electric heating coil. Electric heater coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the drawings.

Gas-fired heating sections shall be completely factory assembled and wired integral within the unit. When located upstream of the cooling coil, the heating section shall be AGA design certified specifically for outdoor applications upstream of a refrigerant cooling coil. The heat exchanger shall be of constructed of minimum 20 gage (0.91mm) aluminized steel. The burner shall be induced or forced draft type with pressure regulator, redundant main gas valve, manual shutoff valve, and intermittent spark ignition. A flame sensing device and high limit safety controls shall be provided. The number of heating stages shall be as indicated in the schedules on the drawings.

The unit shall be supplied with natural gas having a calorific value of approximately 1000 Btu per cubic foot (37 MJ/m^3) at an inlet pressure as indicated.

2.4.09.05 Filters. Filters shall be mounted integral within the packaged air conditioning or heat pump unit and shall be 2 inches (50 mm) thick. Hinged access doors shall be provided. Filters shall conform to the requirements in the Air Filtration Equipment paragraph. Filters shall be washable and reusable.

2.4.09.06 Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons (17.5 kW) and smaller shall have direct or belt driven fans. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons (17.5 kW) shall have V-belt drive with adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Motors and Motor Controls paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the drawings are external to the complete unit. Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column (0.087 kPa) shall be used for 2 inch (50 mm) pleated filter losses.

The outdoor fans shall be direct drive, vertical discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2.4.09.07 Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning or heat pump unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2.4.09.08. Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoors coils, expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, refrigerant piping, and a full operating charge of refrigerant. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, compressor, and refrigerant charge. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

2.4.09.09 Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak and pressure tested. The coils shall be protected with hail guards.

2.4.09.10 Accessories. Where indicated on the drawings, the packaged unit shall be provided with economizer cycle to automatically utilize up to 100 percent of outside air for cooling. The economizer shall be controlled as required, and shall modulate return and outside air dampers to maintain proper discharge temperature into the conditioned space. The dampers shall be equipped with automatic lockout when the outside air temperature is too high for proper cooling, and shall have adjustable minimum position control. The damper motor shall be spring return and shall operate to close the outside damper during shutdown. Means for 100 percent relief of the return air shall be provided.

Where indicated on the drawings, hot gas bypass shall be installed to provide reduced capacity control.

When indicated, packaged units shall be furnished with a roof mounting curb. The curb shall be constructed of at least 16 gage (1.52 mm) zinc-coated steel with nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply and return air openings. The curb shall be a minimum of 16 inches (405 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.4.09.11 Controls. Each packaged unit shall be completely factory wired and shall have a single point power connection and unit mounted disconnect switch. All wiring shall be installed in accordance with the National Electrical Code.

The unit shall be provided with remote control and monitoring panel consisting of system operation switches and signal lights. The signal lights shall be for power, outage, dirty filters, and reset relay.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal volt control power transformer.

Defrost controls, electronic timed initiated and temperature terminated with field adjustable timer shall be provided for all packaged heat pumps. When auxiliary electric heating is provided, a factory installed emergency heat package shall be provided. When heating is locked out, the auxiliary heat shall be activated as necessary.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the drawings.

The thermostat shall be a manual changeover, automatic changeover, or programmable heating and cooling type. The number of stages shall be suitable for the unit control and operation. The thermostat shall have a range of approximately 50 to 90°F (10 to 32°C) with at least a 5°F (3°C) deadband between heating and cooling. The thermostat shall have a subbase to control system and fan operation.

2.4.10 Makeup Air Units. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be Hastings "SBD", Hartzell "GMC", Engineered Air "Series HE", or approved equal for direct fired units and Hastings "Counterflo", Engineered Air "Series DJ", or approved equal for indirect fired units as indicated in the schedules on the drawings. The makeup air units shall be constant volume, gas-fired type, and shall be completely assembled, wired, and flame tested at the factory.

Where indicated in the schedules on the drawings, makeup air units shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.4.10.01 Construction. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, a gas-fired burner section, a filter section, and, when located outdoors, an inlet hood with motorized control damper. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed and hinged doors shall be furnished to provide access to all internal components. An observation port shall be provided on the burner section for viewing the pilot and main flames.

The burner section shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density foil-faced fiberglass blanket insulation securely fastened to the panels. The fan and accessory sections shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density mat-faced cleanable fiberglass blanket insulation securely fastened to the panels. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. The insulation shall meet the requirements of NFPA.

Makeup air units installed outdoors shall be of weatherproof construction, with roof panels pitched for drainage. The roof panels shall be constructed with triple-break seams which overlap the side panels on all sides. All exterior joints shall be bolted or screwed with a gasket, or shall be welded, and shall be sealed weather tight.

Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air shall be mounted on the unit inlet. The hood shall include a two-positioned motorized control damper which opens when the unit is energized and closes when it is de-engerized.

2.4.10.02 Fan Section. The makeup air units shall be equipped with centrifugal fans with forward-curved blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with motors greater than 15 horsepower (11.2 kW) and permanently lubricated or grease lubricated for units with 15 horsepower (11.2 kW) motors and smaller. Units with regreasable bearings shall have externally mounted, grease lubricated bearings or lubrication fittings extended to the exterior fan casing with aluminum or copper tubing and grease fittings rigidly attached to the casing.

Static pressure values indicated in the schedules are external to the complete unit. Internal burner or heat exchanger, filter, and fan housing losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for filter losses.

2.4.10.03 Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors and controls shall be as specified in the Electrical paragraph.

Makeup air units with smaller than 10 horsepower (7.5 kW) motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower (7.5 kW) and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.

2.4.10.04 Heating Section. The complete fuel burning assembly shall conform to the requirements of UL/ETL, FM, or IRI. The burner assembly and gas piping arrangement shall include, but not be limited to, pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valves, and electric modulating main gas valves. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment.

The unit shall be suitable for use with the gas pressure range as indicated.

2.4.10.04.01 Direct Fired. Burners shall be in-line type, suitable for use with natural or propane gas, as required, and shall be complete with stainless steel firing plates, cast iron gas feed, and stainless steel side plates for flame rods and ignition spark rods mounted in ceramic isolated bushings. The profile plates shall be adjustable and shall be sized to maintain the required velocity across the burner. The burners shall be capable of modulating turndown of 20 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff.

2.4.10.04.02 Indirect Fired. Burners shall be modulating power type suitable for use with natural or propane gas, as required. The burners shall be capable of modulating turndown of at least 8 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff. The heat exchanger shall be of 3 or 4 pass design consisting of 400 series stainless steel primary drum heat exchanger with multitube secondary heat exchanger.

2.4.10.05 Filter Section. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute (1.5 m/s) at design conditions unless otherwise indicated in the schedules on the drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch (50 mm) pleated type and shall conform to the Air Filters paragraph. All filters shall be washable and reusable.

2.4.10.06 Controls. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, an electronic discharge air temperature sensor and controller, and a disconnect switch. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the drawings. The controls shall include controls to lock out the burner when the outside air temperature is above the controller setpoint.

A remote control station shall be furnished with the makeup air unit and located where indicated on the drawings. The control station shall allow for remote operation of the unit with a fan "On-Off" switch, a "Winter-Summer" switch, a supply temperature setpoint adjustment, and indicating lights for fan, heat, lockout, and dirty filters. Where indicated in the sequence of operations, a room override thermostat shall be mounted on the panel.

Unit mounted panels shall house adequately sized combination starters rated in accordance with NEMA standards, and dead-front 3 lock nonfused disconnect switches.

2.4.10.07 Accessories. Makeup air units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage (1.90 mm) thickness zinc-coated steel with a nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply air opening as indicated on the drawings. The curb shall be a minimum of 16 inches (400 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.4.11 Heaters. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2.4.11.01 Electric Duct Heaters. Electric duct heaters, denoted by the symbol "EDH" and an identifying number, shall be manufactured by Indeeco, Brasch, or approved equal.

Electric duct heaters shall be furnished and installed where indicated on the drawings.

Electric duct heaters shall be open coil or finned tube, as required, and zero clearance type with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames with 2 inch (50 mm) wide flanges suitable for fastening to the ductwork.

Bushings for open coils shall be ceramic and terminals shall be stainless steel. Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

Heaters shall be completely factory wired and shall be provided with disconnecting backup and safety contactors, transformers, an automatic reset thermal cutout, a manual reset thermal cutout, a disconnect switch, and a differential pressure airflow switch. All interconnecting wiring shall be enclosed in a terminal box fastened to the heaters and oriented as indicated on the drawings. The terminal boxes shall be furnished with double doors.

Contactors shall be 600 volt rated, 3 pole, UL listed, and shall have a life expectancy for 100,000 operations. A built-in industrial dry type 480/120 volt control transformer shall be furnished to carry the full contactor holding coil load. Transformer primary and secondary windings shall be fused. Secondary windings shall have one lead grounded.

The duct heaters shall be furnished with a silicone controlled rectifier (SCR) control unit mounted in the duct heater terminal box. The control unit shall be suitable for the temperature range of 32 to 132°F (0 to 55°C), and shall be a solid-state proportioning controller designed to modulate the heater output from 0 to 100 percent. The duct heaters shall be controlled by a thermostat as indicated on the drawings. The duct heater SCR controller shall be compatible with the signal from the thermostats.

The duct heater output in kW shall be as specified at 460 volts, 60 Hz, 3 phase. The heater elements shall be suitable for operation on 480 volt, 60 Hz, 3 phase power.

2.4.11.02 Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the drawings.

Electric Unit Heaters (non-explosionproof). Electric unit heaters located in unclassified areas shall be Chromalox "LUH" or "VUH", Brasch, or approved equal. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the drawings to be wall hung, a wall mounting bracket shall be provided.

Electric Unit Heaters (explosionproof). Where indicated in the heater schedule on the drawings to be explosionproof, unit heaters shall be manufactured by Indeeco "Ultra-Safe", Ruffneck, Markel, or approved equal. Explosionproof electric unit heaters shall be of the fan forced type with a heat exchanger, fan and motor assembly, automatic reset thermal cutout, built-in contactor, factory installed three pole disconnect switch in NEMA 7 enclosure, and 24 volt control transformer. The heater shall be suitable for use with the power supply indicated in the heater schedule on the drawings. The heater shall be listed for installation in a Class I, Division 1 or 2, Group D location and shall have an NEC ignition code of T3B or better.

The heater cabinets shall be constructed of a corrosion resistant cabinet fabricated from an epoxy coated 14 gage (1.90 mm) thickness steel with individually adjustable outlet blades. Cabinet fasteners shall be stainless steel.

The heat exchanger shall be an efficient liquid to air design utilizing a copper or steel core with aluminum fins. The heat exchanger shall be provided with a coating suitable for use in a corrosive atmosphere consisting of hydrogen sulfide. The heating elements shall be housed in an inhibited propylene or ethylene-glycol heat transfer fluid that is suitable for temperatures down to -49°F (-45°C). A pressure relief valve shall provide overpressure protection for the heat exchanger.

The fan and motor assembly shall consist of an aluminum fan connected to a explosionproof, permanently lubricated ball bearing type motor with built-in thermal overload protection. The motor shall be prewired to the control enclosure providing for a heater that is suitable for use with a single point power connection.

2.4.11.03 Gas Unit Heaters. Gas unit heaters, denoted by the symbol "GUH" and an identifying number, shall be Modine Model HS, Reznor, Trane, Sterling, or approved equal.

Gas unit heaters shall be furnished and installed where indicated on the drawings. Each heater shall be of the type, size, and capacity indicated in the schedules on the drawings; shall be suitable for use with the gas type and pressure as required; and shall be of a type approved and listed in the AGA Directory of Approved Gas Appliances and Accessories.

Each gas-fired unit heater shall be power vented, horizontal discharge, propeller type, and suitable for two point suspending mounting. The heater burner and heat exchanger shall be constructed of E-3 (AISI Type 409) stainless steel. Each heater shall be furnished with a vent cap.

Each gas unit heater shall be furnished complete with a 24 volt transformer, single-stage gas control with a regulated combination redundant gas valve, a spark-ignited, intermittent safety pilot with electronic flame supervision and all required limit and safety controls. Units larger than 125,000 Btu (132,000 kJ) input shall have two-stage gas controls.

The fan motor shall be suitable for use with a 120 volt, 60 Hz, single phase power supply, and shall be provided with automatic reset thermal overload protection.

2.4.11.04 Wall Heaters. Wall heaters, denoted by the symbol "WH" and an identifying number, shall be manufactured by Electromode "Model EWA", Brasch, or approved equal.

Wall heaters shall be downflow type; designed for surface mounting; and shall include an electric heating element, a thermal limit switch, a fan delay switch, a fan and motor assembly, and a built-in thermostat. The heaters shall be suitable for use with the specified power supply and shall have the capacity indicated in the schedules on the drawings.

2.4.12 Fans. Each fan shall be complete with an electric motor, a drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower (7.5 kW) motors and fixed sheaves for 10 horsepower (7.5 kW) and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

Fan drive motors and controls shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the drawings.

Fans indicated in the schedules on the drawings to be explosionproof shall be suitable for installation in a NEC Class I, Division 2, Group D environment.

The external static pressure values indicated in the schedules on the drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for pleated filter losses.

A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp (0.4 kW) to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

Where indicated in the schedules on the drawings, fans shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.4.12.01 Cabinet Fans. Cabinet fans, denoted by the symbol "CF" and an identifying number, shall be Greenheck "Model SP" or “Model CSP”, Penn Ventilator, Loren Cook, or approved equal. Cabinet fans shall have steel, forward-curved, squirrel-cage type wheels. The fans shall be statically and dynamically balanced. Motors shall be open dripproof, PSC, with permanently lubricated ball bearings and internal thermal overload protection, and shall be suitable for use with the power supply indicated in the schedules on the drawings. Fan housings shall be fabricated of heavy gage carbon steel with welded seams and shall be acoustically lined and factory primed. Fans shall be installed in the configuration indicated on the drawings. A removable access panel or exhaust grille shall be provided on the bottom of each fan and a factory installed backdraft damper shall be provided on the fan discharge. Vibration isolator units and wall caps shall be provided for each fan as indicated in the schedules on the drawings.

2.4.12.02 Duct In-Line Fans. Duct fans, denoted by the symbol "DF" and an identifying number, shall be Greenheck "SQ", Penn Ventilator, Loren Cook, or approved equal. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.

The fan housing shall be square, constructed of aluminum or heavy gage steel as required, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch (25 mm) fiberglass duct liner.

Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, permanently sealed pillow block bearings.

Flexible wiring leads shall be provided from the fan motor to an external junction box and disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

2.4.12.03 Duct Axial Fans. Duct axial fans, denoted by DAF and an identifying number, shall be Hartzell, Greenheck, Penn Ventilator, Loren cook, or approved equal. The model and type (fiberglass or stainless steel) of each fan is per Fan Schedule shown on the Drawings. Duct axial fans shall be of the axial belt drive type fan built to be installed in duct systems for process ventilation applications, and where the nature of the corrosive airstream warrants isolation of the motor and drive assembly from the airstream.

The fan housing shall be round, constructed of fiberglass or heavy gage stainless steel as required, and shall be furnished with duct mounting collars. Vibration isolation units shall be provided for each installed fan.

Motor and drives shall be isolated from the air stream. The six-blade propeller shaft shall be stainless steel construction, mounted in heavy duty self-aligning bearings.

2.4.12.04 Power Roof Ventilators. Power roof ventilators, denoted by the symbol "PRV" and an identifying number, shall be Greenheck "G" or "GB", Penn Ventilator "Domex", Loren Cook, or approved equal.

Power roof ventilators shall be centrifugal or propeller type, as indicated in the schedules on the drawings, and shall be statically and dynamically balanced for quiet, vibration-free operation. Each fan shall be complete with a weather hood, a safety disconnect switch mounted in the hood, a 1/2 inch (13 mm) mesh aluminum bird screen over all openings, and, where indicated in the schedules on the drawings, a backdraft damper. Fan housings shall be constructed of aluminum and shall have an aluminum base of the self-flashing type, suitable for mounting on the curbs indicated on the drawings.

2.4.12.05 Propeller Fans. Propeller fans, denoted by the symbol "PF" and an identifying number, shall be Greenheck "Model S" or "Model SC" for direct drive and "Model SB" or "Model SBC" for belt drive, Penn Ventilator, Loren Cook, or approved equal.

Propeller fans shall consist of a panel frame, a wire guard, a motor, and fan blades. Fan blades shall be steel or aluminum, as required. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.

When indicated in the schedules on the drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, backdraft damper, and weather hood with birdscreen.

2.4.12.06 Utility Fans. Utility fans, denoted by the symbol "UF" and an identifying number, shall be Greenheck "Model SWB", Penn Ventilator, Loren Cook, or approved equal.

Utility fans shall be multiblade, squirrel-cage type, with nonoverloading type blades. The fans shall be statically and dynamically balanced for quiet, vibration-free operation and shall be provided with vibration isolators. Fan inlets and outlets shall be provided with removable angles and bolts for attaching flexible connections. Fan housings shall be heavy gage steel, of all-welded construction and shall be shop coated with universal primer. Fan bearings shall be of the self-aligning, ball type.

2.4.12.07 Wall Fans. Wall fans, denoted by the symbol "WF" and an identifying number, shall be Greenheck "Model GW" or "Model GWB", Penn Ventilator, Loren Cook, or approved equal. Wall fans shall be suitable for sidewall installation; shall be direct or belt driven, centrifugal type, with aluminum wheels and housing, and a wheel guard located on the discharge side; and shall be statically and dynamically balanced at the factory. The fan motors shall be of adequate size to prevent overloading when operating at the specified capacity and shall be suitable for use with the power supply indicated in the schedules on the drawings.

2.4.12.08 Vault Supply Fans. Vault supply fans shall be in-line centrifugal type fiberglass construction, belt driven with removable fiberglass motor guard. Units shall be furnished with integral flanges and straightening vanes. Fan shaft shall be stainless steel construction with Viton seals. Bearing to be sealed pillow block type. Refer to drawings and fan equipment schedule for additional information.

2.4.13 Roof Hoods. Roof hoods, denoted by the symbol "RH" and an identifying number, shall be Greenheck "Model FHI" or "FHR", Penn Ventilator, Loren Cook, or approved equal.

Roof hoods shall be suitable for air intake or exhaust and shall have throat dimensions as indicated in the schedules on the drawings. As required, the roof hood assembly shall be constructed of galvanized steel or aluminum. Each roof hood shall be complete with a weather hood, a 1/2 inch (13 mm) mesh aluminum or galvanized bird screen over all openings, and a mounting base suitable for installation on a curb as indicated on the drawings.

Where indicated in the schedules on the drawings, roof hoods shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.4.14 Dampers.

2.4.14.01 Backdraft Dampers. Backdraft dampers, denoted by the symbol "BDD", shall be Arrow United Industries "Type 655", Ruskin, or approved equal. Backdraft dampers shall be constructed with a 1 by 4 inch by 0.081 inch thick (25 by 100 mm by 2 mm) extruded aluminum frame. Blades shall be of 0.081 inch (2 mm) aluminum, with silicone rubber seals on the edges, and with aluminum shafts and ball bearings.

2.4.14.02 Control Dampers. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet (2.3 m^2) or with any dimension exceeding 48 inches (1200 mm) shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit.

Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

Control dampers shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.4.14.02.01 Duct Mounted Control Dampers. Control dampers and face bypass dampers mounted in ductwork and equipment curbs shall be Ruskin "CD-50", Arrow United Industries "Type AFD-20", or approved equal. The damper frames shall be constructed of 5 inch (125 mm) Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch (150 mm) wide airfoil-shaped extruded aluminum.

Control dampers denoted on the drawings to be face and bypass dampers shall be vertically arranged. The face damper dimensions shall be coordinated with the heating coil dimensions. The bypass area shall be half the area of the face damper. Face and bypass damper submittals shall indicate coil size, face dimensions, and bypass dimensions.

2.4.14.02.02 Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Ruskin "CD-40", Arrow United Industries "Type AFD-20", or approved equal. Control damper frames shall be constructed of 4 by 1 inch (100 by 25 mm) 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch (100 mm) wide airfoil-shaped extruded aluminum.

2.4.14.02.03 Round Control Dampers. Round control dampers shall be Arrow United Industries "Type 70, 75, or 80", or approved equal. The damper frames and blades shall be constructed of the material as required.

2.4.14.03 Volume Control Dampers. Volume control dampers shall be denoted by the symbol "VCD". Volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD", Ruskin “Model MDRS25” , or approved equal. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770", Ruskin “Model MD35” , or approved equal.

Rectangular volume control dampers shall be fabricated of 16 gage (1.52 mm) thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch (100 mm or 125 mm by 25 mm) channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch (178 mm) long, 22 gage (0.76 mm) thickness frame, and a minimum 20 gage (0.91 mm) thickness circular blade.

The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

2.4.14.04 Fire Dampers. Fire dampers, denoted by the symbol “FD”, installed in positions having a fire resistance rating of less than 3 hours shall be Air Balance Inc. “Model D19”, Ruskin “Model DIBD2”, or approved equal. Fire dampers installed in partitions having a fire resistance rating of 3 hours or more shall be Air Balance Inc. “Model D30”, Ruskin “Model DIBD23”, or approved equal. Fire dampers shall be style “B” for ducted and style “A” for non-ducted applications unless otherwise indicated on the Drawings.

Dampers shall have a 5 inch (125mm) side galvanized steel channel frame, galvanized steel interlocking blades, stainless steel closure springs and latches, 165°F (74°C) fusible links, and a 20 gage (0.91 mm) thickness galvanized steel housing. Factory fabricated sleeves and mounting angles shall be furnished for each damper for mounting as indicated on the Drawings. Fire dampers shall be rated in accordance with UL-555 for use in dynamic systems.

2.4.15 Damper Operators. The damper operators shall be direct coupled or linkage type. Where linkage type operators are used, each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

Each operator shall have sufficient torque to operate the connected control damper area. Each damper operator shall have at least a 50 inch-pound (5.6 N-m) normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators shall be furnished to produce the normal running torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the drawings. Face dampers shall fail to the closed position and bypass dampers to the open position.

Where damper operators are installed in explosionproof rated areas indicated on the drawings, the operators shall be furnished and installed in explosionproof housings suitable for installation in an NEC Class I, Division 2, Group D area. Where damper operators are installed outdoors, the operators shall be furnished and installed in weathertight enclosures.

Two-position direct coupled electric damper operators shall be Belimo "NF120-S", Honeywell "ML4195", Johnson Controls, or approved equal. Linkage type electric damper operators shall be Honeywell "Model M4185", Johnson Controls "Model M100", or approved equal. Two-position electric damper operators in hazardous areas shall be installed in explosion proof housings.

Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA Type 1 enclosure fastened to the motor housing.

Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable. The operators shall be suitable for direct mounting to shafts up to 1 inch (25 mm) and shall be complete with mounting brackets and damper position indicator.

Linkage type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch (9.5 mm) square, double-ended drive shaft.

2.4.16 Air Outlet and Inlet Devices. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, Titus, or approved equal. Air outlet and inlet devices shall be furnished and installed where indicated on the drawings.

Air outlet and inlet devices shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.4.16.01 Ceiling Diffusers. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the drawings. Size, location, and direction of airflow shall be as indicated on the drawings.

2.4.16.02 Registers and Grilles. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

2.4.17 Flexible Connections. Flexible connections located indoors shall be Ventfabrics "Ventglas", or approved equal. Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon", or approved equal.

Ductwork connections to the air handling equipment, and where indicated on the drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches (76 mm) of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20 to 180°F (-29 to 82°C) and shall weigh at least 27 ounces per square yard (915 g/m^2).

Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10 to 250°F (-23 to 121°C) and shall weigh at least 24 ounces per square yard (814 g/m^2).

2.4.18 Air Filtration Equipment.

2.4.18.01 Pleated Air Filters. Pleated air filters shall be American Air Filter "AM-AIR 300X", Farr "30/30", or approved equal. Filters shall be washable and reusable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have an average efficiency of 25 to 30 percent based on the ASHRAE 52.1 test method.

One inch (25 mm) filters shall have at least 14 pleats per linear foot (0.3 m) and at least 1.9 square feet of media per square foot of filter area (1.9 square meters per square meter). One inch (25 mm) filters shall have a maximum initial resistance of 0.10 inch wc at 300 feet per minute (0.02 kPa at 1.5 m/s).

Two inch (50 mm) filters shall have at least 12 pleats per linear foot (0.3 m) and at least 4.2 square feet of media per square foot of filter area. (4.2 square meters per square meter). Two inch (50 mm) filters shall have a maximum initial resistance of 0.13 inch wc at 300 feet per minute (0.03 kPa at 1.5 m/s).

2.4.18.02 Side Access Filter Housings. Side access filter housings shall be American Air Filter "Access Air", Farr "Model 4P Glide/Pack", or approved equal. Side access filter housings shall be single-stage, factory-fabricated of 16 gage (1.52 mm) thickness galvanized steel and shall be equipped with flanges for connection to the ductwork. Access doors shall be 16 gage (1.52 mm) thickness galvanized steel and shall be positioned to allow replacement of filters from either side of the housing. Filter housings and doors shall be insulated and of double-wall construction. Filter tracks shall be provided to accommodate nominal 2 inch (51 mm) thick washable and reusable filters as described herein. Leakage at the rated airflow shall be less than 1 percent at a 3 inch wc (0.75 kPa) differential.

2.4.19 Draft Gauges. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge", or approved equal.

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch (89 mm) diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140°F (-7 to 60°C), and a range of 0 to 1.0 inch wc (0.25 kPa), with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves.

2.4.20 Sheet Metal Work. The ductwork, accessories, bracing, and supports shall be constructed of the material as required. Galvanized ductwork located in air conditioned spaces shall be constructed of G-60 or better lockforming quality in accordance with ASTM A653. All other galvanized ductwork shall be constructed of G-90 or better galvanized steel. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Plenums shall be constructed of reinforced 16 gage (1.52 mm) thickness galvanized sheet metal.

Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch (25 mm).

Sheet metal fan boxes shall be fabricated with 12 gage (2.66 mm) thickness galvanized sheet metal skin and structural steel framing of sufficient strength to support the fan box and the fan mounted on the box. The framing shall be coated with a universal primer. All welds on galvanized metal shall be cleaned and coated with a zinc-rich paint. Drawings of the fan boxes shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

Where indicated on the drawings, ductwork and accessories shall be given a protective coating resistant to the corrosive atmosphere.

2.4.21 Duct Insulation. Interior duct liner shall be Knauf "Duct Liner E M", CertainTeed "ToughGard R", Schuller "Permacote-Linacoustic", or approved equal.

Interior duct liner shall be 1-1/2 pound per cubic foot (24 kg/m^3) density, spray coated duct liner with an "R" value of at least 3.6 $ft^2 \cdot hr \cdot °F/BTU$ (0.63 $m^2 \cdot °C/W$) per 1 inch (25 mm) thickness. The insulation shall be suitable for temperatures up to 250°F (121°C) and shall have at least a 0.55 NRC per 1 inch (25 mm) thickness. The insulation shall conform to ASTM C1071.

2.4.22 Flexible Duct and Takeoffs. Flexible duct shall be Flexmaster "Type 9", Flexible Technologies "Thermaflex Type G-KM", or approved equal. Takeoffs shall be Buckley Air Products "Air-Tite Bellmouth BM-D", or approved equal.

Flexible duct shall be a galvanized or vinyl-coated spring steel helix, bonded to a polymer liner, and wrapped with glass fiber insulation suitable for use in heating and cooling systems. The insulation shall provide an "R" value of at least 4.2 $ft^2 \cdot hr \cdot$ °F/BTU (0.74 $m^2 \cdot$ °C/W). The outer jacket shall be a vapor barrier of fire retardant polyethelene or polyolefin material. The flexible duct shall be listed under UL 181 as Class 1 flexible air duct and shall comply with the latest edition of NFPA 90A.

Takeoffs for the flexible duct shall be bellmouth type manufactured of galvanized steel with a neoprene gasket and predrilled holes. Each takeoff shall be equipped with a balance damper constructed of 26 gage (0.45 mm) thickness galvanized steel. Scoops or other obstructions in the main duct will not be acceptable.

2.4.23 Access Doors. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2.4.24 Temperature Controls. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; Siemens Building Technologies, Landis Division, or approved equal. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2.4.24.01 Performance and Design Requirements. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. Where cable and conduit is not indicated on the drawings but is needed for a complete and functional control system in accordance with the sequence of operation it shall be provided as specified herein. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation.

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper actuators, thermostats, temperature control panels, pressure differential switches, control switches, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the Electric Wiring paragraph. Cable and conduit for all HVAC power circuits shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.4.24.02 Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ± 2°F (1.1°C), and the relative humidity within ± 5 percent of the setpoint.

2.4.24.03 Thermostats.

Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", Siemens Building Technologies, or approved equal.

Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 3.5°F (2°C). The thermostats shall have a spdt switch rated for 1 horsepower (0.746 kW).

Low Limit Thermostats. Low limit thermostats shall be Honeywell "L480", Penn Controls "Model A11A-1", Siemens Building Technologies, or approved equal.

Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet (6 m) long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35°F to 45°F (2°C to 7°C), and shall be manually reset.

Modulating Duct Mounted Thermostats. Modulating, duct mounted thermostats shall be Honeywell "Model T991", Penn Controls "Model A80ABA-2", Siemens Building Technologies, or approved equal.

Modulating, duct mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have a range of approximately 10°F to 90°F (-12°C to 32°C) with an adjustable throttling range of approximately 5°F to 24°F (3°C to 13°C), and shall be furnished with a duct mounting kit.

Explosion-proof Thermostats. Explosion-proof wall-mounted thermostats controlling explosion-proof equipment in Class I, Division 2, Group D areas shall be Honeywell "Model T6051B", Johnson Controls, Siemens Building Technologies, or approved equal.

Duct-mounted thermostats controlling explosion-proof equipment in Class I, Division 2, Group D areas shall be Indeeco "Model T94A-70".

Explosion-proof thermostats shall be suitable for installation in explosion-proof areas.

2.4.24.04 Temperature Control Panels. Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be NEMA Type 12 designed for wall mounting and shall be completely prewired and checked. Temperature control panel enclosures shall be manufactured by Hoffman Engineering, Integration Technology Systems Inc, Par Metal Products Inc, or approved equal.

All electrical accessory devices and internal wiring shall be furnished and installed.

All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm and indicating lights, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel. Accessories such as indicating lights and selector switches shall be mounted on the front hinged covers of the panels. The accessories shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panel with corrosion-resistant pan head screws.

Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, and smoke detectors. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operation on the drawings.

All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame resistant covering rated for at least 90°C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Wiring for secondary power distribution and for control, annunciator, and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the legend on the panel wiring diagrams.

Selector Switches. Selector switches shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Selector switches shall be heavy-duty oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.

Push Buttons. Push buttons shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

Indicating Lights. Indicating lights shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Alarm, indicator, and running status lights shall be furnished with bulbs. Indicating lights shall be heavy-duty, push-to-test, oiltight type with low voltage bulbs and built-in transformers. Legends shall be engraved on the lens or on a legend faceplate. Bulbs shall be easily replaceable from the front of the device.

Alarm Horns. Alarm horns shall be Federal Signal "Model 350", or approved equal. Alarm horns shall have a sound output of 100 dB at 10 feet (3 m) and shall be rated for 120 volts ac. Horns shall be furnished with mounting hardware suitable for flush mounting.

Relays. Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; Struthers-Dunn "Series A3, A4", or approved equal. Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or engraved switch settings marked in seconds and shall have timing repeatability of ± 2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

Terminal Blocks and Panel Wiring. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.

A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches (200 mm) of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.

All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts.

Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of the depth of the duct available for future use after the installation including all field wiring, has been completed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

Where signal wiring must be routed to more than one panel or device, the requested circuit routing shall be as indicated on the electrical one-line diagrams.

Control Power Transformers. Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.

Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils (100 μm). One quart (0.95 L) of paint shall be furnished with the panels for future touchup painting.

2.4.24.05 Temperature Indicators.

2.4.24.05.01 Dial Thermometers. A dial thermometer shall be supplied and installed at each remote bulb sensor for calibration and calibration checks. The range of the dial thermometers shall be -40°F to 120°F (-40°C to 49°C).

In ducted systems containing coils or electric duct heaters, a dial thermometer shall be furnished and installed on the downstream side of the coil or heater. Thermometers shall be complete with averaging type elements.

2.4.24.06 Smoke Detectors. Smoke detectors, denoted by the symbol "SMD" and an identifying number, shall be System Sensor “DH100”, Simplex, Grinnell, or approved equal.

Detectors shall be designed to detect combustion gases, fire, and smoke in air conditioning and ventilating duct systems in compliance with the NFPA 90A and shall contain a detector and air sampling chamber which serves as a reference point to help stabilize the detector against the effects of changes in temperature, humidity, and pressure.

Smoke detectors shall be duct mounted photoelectric type and shall be completely self-contained, including integral power supply, supervisory and control circuitry and three sets of isolated contacts. The alarm contacts shall be spst normally open; the auxiliary alarm contact shall be spdt, and the trouble contact shall be spdt and shall indicated detector malfunction. The alarm and trouble contacts shall be rated 2 amperes at 30 volts dc. The auxiliary alarm contact shall be rated 10 amperes at 120 volts ac. Pilot lights shall be provided for visual indication of alarm and power supply status on the front of the unit. A remote key-operated test station with alarm light and power supply status shall also be furnished and installed where indicated on the drawings. Detectors shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply.

Detectors shall be provided with sampling tubes extending the width of the air duct.

2.4.24.07 Pressure Differential Switches. The pressure differential switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Initial setpoints shall be as indicated on the drawings. Differential switches shall be UL listed.

Where indicated on the drawings, pressure differential switches shall be provided with an explosion-proof housing suitable for a NEC Class 1, Division 2, Group D environment. Where differential pressure switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided.

2.4.24.07.01 Airflow Switches. Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800", or approved equal. Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spst, shall be rated 5 amperes at 120 volts ac and for a temperature range of -20°F to 125°F (-29°C to 52°C), and shall be provided with corrosion resistant mounting brackets. Pressure differential switches located across filters shall be initially set at 0.5 inch wc (125 Pa).

2.4.24.08 Control Stations. Control stations for high rate ventilation fans shall include a two position selector switch with nameplate labeled "High Rate Ventilation On/Off". Control stations shall also include two indicating lights for "On/Off" indication. Indicating lights and selector switches shall be heavy duty oiltight NEMA

Type 13. The control station enclosure shall be NEMA Type 4. Control stations shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.4.24.09 Emergency Ventilation Shutoff Switches. Emergency ventilation shutoff switches shall be double-action manual fire alarm stations. The switches shall be Simplex "Series 2099", or approved equal. The switch operation shall require that a hammer, hung on the front of the station, be lifted and thrown downward against the glass window, thus breaking it to expose the recessed pull lever. The switches shall be provided with phenolic nameplates identifying the switches as "VENTILATION SYSTEM EMERGENCY SHUTOFF". The nameplates shall cover the words "FIRE ALARM" on the switches. Switches located on the exterior of the building shall be provided with a weather protective shield.

2.4.24.10 Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2.4.24.11 Electrical Wiring. Detailed wiring diagrams shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.

Control wiring shall be in accordance with the National Electric Code (NEC). Cable shall be multi-conductor, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations.

Conduit for all HVAC control circuits shall be EMT, except in areas designated on the electrical drawings as Area Type 1A, Area Type 4, or Area Type 12. In areas designated Type 1A, conduit shall be exposed rigid PVC non-metallic conduit with PVC fittings, boxes, and accessories. In areas designated Type 4 and Type 12, conduit shall be IMC with gasketed enclosures and fittings. All conduit and conduit installation shall be in accordance with the requirements of Master Specification Section 16050, Electrical General Requirements and NEC.

2.4.25 Electrical. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.4.26 Drive Units. Drive units shall be designed for 24 hour continuous service.

2.4.26.01 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor.

2.4.26.02 Safety Guards. All belt drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.4.26.03 Electric Motors. Motors furnished with equipment shall meet the following requirements.

A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feed and chemical handling locations.

4. Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor’S option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
   115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
   460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase.
Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

Motors to be used with adjustable frequency drives shall be rated for inverted service.

2.4.27 Shop Testing. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

2.4.28 Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3.2.02 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Flues. Flues for all equipment exhausting combustible material shall be installed where indicated on the drawings. Flue gas systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

Flues shall be supported where indicated on the drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the flue systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

The flue height dimensions indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

All vertical flues shall be equipped with a capped tee to serve as a condensate drain. Flues 6 inches (150 mm) and larger shall be equipped with a condensate drain connection.

When power vented equipment is listed as being suitable for use with "Type B" gas vents, "Type B" gas vents may be used when all vent joints are sealed to prevent leakage.

Where metal flues are used, each joint shall be sealed with sealant and/or aluminum or teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Where single wall metal flues are used to vent equipment, a double wall flue shall be used outside and shall extend through the wall a minimum of 6 inches (150 mm). The annular space of the double wall flue shall be sealed at the connection point between the double and single wall flues. Single wall flues routed through unconditioned spaces or in locations below 8 feet (2.4 m) above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150°F (65°C).

Gas unit heater flues shall be installed with a minimum of 12 inches (300 mm) of straight pipe attached to the venter outlet before the installation of an elbow.

3.3.02 Packaged Air Conditioning Units/Packaged Heat Pumps. The packaged air conditioning units and packaged heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the drawings.

3.3.03 Makeup Air Units. Flexible connections shall not be in tension when the fans are operating.

3.3.04 Heaters. The bottom elevation of unit heaters shall be 8 feet (2.4 m) above finished floor unless otherwise indicated.

Gas fired unit heaters with side burner and control access shall have the access located on heater side opposite the wall.

Electric duct heaters shall be installed with a minimum distance of 4 feet (1.2 m) from all ductwork transitions and obstructions on both sides of the heater.

3.3.05 Fans. Flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

Power roof ventilators shall be secured with corrosion resistant lag screws to the roof curb.

3.3.06 Roof Hoods. Roof hoods shall be secured with corrosion resistant lag screws to the roof curb.

3.3.07 Damper Operators. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position, face dampers shall fail to the closed position, and bypass dampers to the open position.

3.3.08 Air Outlet and Inlet Devices. Diffusers with balance dampers installed in the flexible duct takeoffs shall not have an opposed blade damper mounted in the throat of the diffuser.

Ceiling mounted air terminals or services weighing 20 pounds (89 N) shall be supported directly from the structure.

3.3.09 Draft Gauges. Draft gauges for filters located more than 8 feet (2.4 m) above the finished floor shall be mounted on the nearest wall, 5.5 feet (1.7 m) above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

3.3.10 Sheet Metal Work. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards. The locations, arrangement, and sizes of ductwork shall be as indicated on the drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

Ductwork shall be constructed and installed in accordance with the drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet (2.4 m) above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch (200 mm) lighting allowance between the ceiling and the bottom of the ductwork.

In vertical ducts with a closed bottom which terminate less than 24 inches (600 mm) above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch (12.5 mm) drain hole in the bottom of the duct.

Single-thickness turning vanes shall be installed in all turns with 45 degree or greater angles.

3.3.11 Duct Insulation. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces which are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.

Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches (200 mm) on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

The following ducts shall be insulated with a one inch (25 mm) thick interior duct liner unless otherwise indicated or indicated on the drawings to be wrapped:

Makeup or outside air ducts.

Air conditioning system supply and return ducts.

Other ducts where indicated on the drawings.

3.3.12 Flexible Duct and Takeoffs. The length of the flexible ductwork shall not exceed 8 feet (2.4 m). All support saddles for flexible duct shall be a minimum of 6 inches (150 mm) wide.

3.3.13 Access Doors. Airtight access doors shall be provided for inspection of all control dampers, fire dampers, smoke dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches (200 mm) square for hand access, 18 inches (450 mm) for shoulder access, or as indicated on the drawings. Each access door shall be installed to open against the pressure in the duct.

3.3.14 Temperature Controls. Automatic temperature controls shall be furnished and installed as indicated on the drawings and as specified herein.

Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the drawings. Control equipment shall be installed with adequate space for operating and maintenance access.

3.3.14.01 Temperature Control Panels. The panels shall be mounted so that selector switches and indicating lights on the panel are located approximately 5 feet (1.5 m) above the finished floor.

3.3.14.02 Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in Master Specification Section 16050, Electrical General Requirements. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3.14.03 Device Tag Numbering System. All field mounted control devices shall be identified with an identification plate as described in the Equipment Identification paragraph securely fastened to the device. The device identification shall agree with those listed on the drawings. Hand-lettered or tape labels will not be acceptable.

Identification plates for thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the device identification list the controlled equipment in parenthesis below the device number.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15510

HEATING BOILERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heating system boilers and associated devices and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

When required, each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Equipment Motors

Name of manufacturer.

Type and model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Bearing types and numbers.

Weight.

Overall dimensions.

Full load amperes, efficiency, and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Data and Manuals. When required, operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

Flue piping and fittings shall be factory built, laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211.

Gas fired boilers shall be rated in accordance with the provisions of the American Gas Association, shall have AGA certified input and gross output ratings, and shall be listed by I-B-R. The gas fired boilers and control components shall be tested in accordance with ANSI Z21.13b. All electrical safety controls shall be of accepted quality and shall be UL and AGA certified. Each boiler shall be constructed in accordance with Section IV of the ASME Boiler and Pressure Vessel Code, shall be stamped with the official ASME symbol, and shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. As required, extra materials shall be furnished for the equipment.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules. Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as required.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as required.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 GAS-FIRED HEATING WATER BOILERS. Gas fired heating water boilers, denoted by the symbol "HWB" and an identifying number, shall be Weil-McLain, Peerless, or approved equal. The boiler model shall be as required.

The boiler shall be furnished complete with a burner assembly, firing controls, control panel, fuel valve gas trains, electrical wiring, safety equipment, a structural steel base, and all accessories and appurtenances specified or required for a complete, properly operating installation.

2.5.01 Performance and Design Requirements. The boiler shall be listed by I-B-R, shall be designed for the I-B-R capacities indicated in the schedule on the drawings, and shall be capable of developing the full I-B-R listed output at 100 percent firing rate. The heating water boiler shall be stamped for the maximum working pressure as required.

2.5.02 Boiler Construction. The boiler shall be a factory assembled package, atmospheric or forced draft burner type as required, low pressure, wet base design, cast iron, sectional type.

Where the boiler physical size precludes the use of a packaged unit and with the written concurrence of Engineer, a field assembled unit will be acceptable. To minimize field assembly work, major components shall be shop assembled to the maximum extent practicable.

The boilers shall be designed for vertical travel of flue gas. Each section of the boiler shall be manufactured with cast-on heat absorbing studs to achieve efficient and rapid heat transfer from the combustion gases to the boiler water. Boiler sections shall be fabricated with ground-faced metal-to-metal joints which do not need putty, cement, or other filler.

Each boiler shall be equipped with access openings for cleaning the flueways between sections.

The boilers shall be provided with a built-in air elimination system to ensure positive separation of air from circulating water. The boilers shall be constructed to provide balanced water flow through the entire boiler. Forced draft boilers shall be designed and constructed so that the combustion chamber is completely surrounded by circulating water.

The boiler sections shall be furnished with a flue collector hood and horizontal to vertical draft hood constructed of heavy gage aluminized steel. The flue collector hood shall be securely bolted to the top of the boiler sections. A gastight seal shall be maintained between the flue collector hood and the top of the boiler sections.

The boilers shall be furnished with insulated heavy gage steel jackets with baked enamel finish and insulated with heavy density fiberglass on the left and right ends, top, back, and interior panels. The jackets shall be designed for installation after the supply and return piping have been connected and shall be easily removable.

Observation ports shall be mounted on the front and back sections of the boiler to permit visual inspection of the burner flame.

The boiler end sections shall be provided with suitable tappings for connection of supply and return piping and controls.

2.5.03 Burner Assembly. The boiler shall be furnished with and designed for use with the burner type and fuel gas type as required.

The atmospheric type main burners shall be aluminized steel of one-piece construction suitable for high flame temperature, quiet ignition and extinction, and reliable flame retention. The burners shall be designed so the proper amount of primary combustion air will be drawn into the burner throat entry over a range of burner manifold gas pressures as required.

The forced draft type burner shall be modulating, low fire start, power gas type, designed to burn the type of fuel as required without vibration, noise, or pulsations. The burner shall incorporate a stainless steel flame retention type combustion head and shall be equipped with an external primary-secondary air ratio adjustment and total air volume adjustment. A permanent observation port shall be provided to allow observation of both pilot and main flames. The burner shall be equipped with a forced draft air fan sized to supply the air required for proper combustion of the specified fuel. The unit shall be equipped with an airflow switch to shut off the fuel supply upon failure of the combustion air.

The complete fuel burning assembly shall conform to the requirements of the UL, FM, or the IRI as required. The fuel train shall consist of pressure regulators, shutoff valves, gas valves, high and low gas pressure switches, and vent valves. The fuel train piping shall include 1/4 inch (6 mm) pressure tappings with pipe plugs upstream and downstream from each valve and regulator.

2.5.04 Boiler Trim. The boilers shall be furnished with combination pressure-temperature gauges to indicate boiler water temperature and system pressure. The combination gauges shall be of rugged, guarded type construction with clearly marked and easy to read dials.

Each boiler shall be furnished with a relief valve. The relief valve shall be of the side outlet discharge type, shall be ASME certified, and shall be set to relieve at the rated boiler ASME working pressure. The valve shall have a discharge capacity equal to or greater than the listed I-B-R gross output of the boiler.

A stack thermometer shall be furnished with each boiler for installation in the boiler vent.

2.5.05 Controls. Burner controls shall be provided for control of the fuel supply to the burner and pilot. The gas control components shall be located outside the boiler jacket for easy access, adjustment, and servicing. The automatic safety pilot system shall provide 100 percent shutoff.

Electronic flame rectification controls and intermittent electric ignition pilot systems shall be provided for each boiler. The safety pilot shall be intermittent burning, electrically ignited, and electronically supervised. In the event of flame failure, the controls shall automatically interrupt the fuel supply to the pilot and burner, sound an audible alarm, and light a visual indicator. After shutdown caused by flame failure, the burner shall have to be manually restarted.

Controls shall provide at least a 30 second pre-purge of the combustion chamber before ignition of the fuel and a 15 second or longer post-purge after interruption of the fuel supply.

The boilers shall be furnished with operating, high temperature, and low water cut-off controls. The operating controller shall be set to maintain the temperature of the water leaving the boiler. The high limit control shall be set at least 20°F (11°C) higher than the design leaving water temperature. The low water cut-off control shall be manually reset and shall automatically prevent boiler operation when the boiler water level falls below the safe limit.

The controls shall include automatic spark ignition and provisions for automatic restarting after a power failure or momentary interruption of the fuel supply.

2.5.06 Control Panel. The boiler controls shall be mounted on an electrical control panel which shall include a circuit breaker for 480 volt, 60 Hz, 3 phase power supply, a forced draft blower motor starter for forced draft type burners, burner firing controls, an ignition transformer, an alarm bell, and all electrical controls and devices specified herein or otherwise required for proper operation of the equipment.

All controls shall be housed in NEMA Type 1 enclosures. All external wiring shall be enclosed in conduit.

All electrical components shall be factory-installed and wired so that only connection of the power supply circuit to the control panel is required during installation of the equipment. A control power transformer for the load of all accessory devices listed in the Sequence of Operations shall be included to supply 120 volt control power.

The boiler control panel shall include an isolated contact for use with the temperature control system to indicate boiler trouble. The contact shall close in the event boiler operation is interrupted by flame failure, low water cutoff, or limit control.

2.6 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.7 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.7.01 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.7.02 Electric Motors. Motors furnished with equipment shall meet the following requirements unless otherwise specified in the motors specification:

> A manufacturer's standard motor may be supplied on packaged equipment, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.
>
> Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.
>
> Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), departure from rated voltage and frequency, poor ventilation, or frequent starting, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
   115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
   460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase. Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.8 SHOP TESTING. Each individual section of the gas fired boilers shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

When required, the equipment shall be factory tested. Factory test results shall be delivered to Engineer. Equipment shall not be shipped until Engineer has reviewed the test results and advised Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

2.9 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of topcoats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.3.01 Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body.

3.3.02 Gas Heating Water Boiler. The boilers shall be installed in accordance with the manufacturer's recommendations, and in a neat and workmanlike manner.

The boiler sections shall be held together by individual draw rods at the front and back of the assembly. A permanent gastight seal shall be maintained between the boiler sections.

Boiler installation shall include provisions for removing burners; adjusting, cleaning, and lubricating working parts; and replacing controls, safety devices, and other control components.

All boiler sections shall be sealed with high temperature mastic sealant in accommodating sealing grooves to provide a permanent gastight seal. Each port opening shall be equipped with a flexible elastomer sealing ring to ensure a permanent watertight seal between the boiler sections.

Care shall be exercised to avoid the transmission of pipe stresses to the equipment. The boiler shall be operated, adjusted, and tested after installation to confirm proper adjustment and operation of all controls.

Where required by applicable codes, gas train vent piping shall be routed to outdoors at a location acceptable to Engineer.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. When required, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field tests and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Initial startup of the boilers, including all burner equipment and burner controls, shall be provided through a qualified manufacturer's representative who shall record all burner and control settings. Copies of the records shall be made available to Engineer prior to acceptance of the equipment.

3.4.03 Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided as required. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner. Each boiler shall be thoroughly cleaned in accordance with the manufacturer's instructions prior to being placed in service.

End of Section

SECTION 15515

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of specialty valves, expansion tanks, air separators, pumps, devices, and appurtenances associated with the heating, ventilating and air conditioning hydronic systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturer's names have been listed as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as specified in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, and valves denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment

Name of manufacturer

Type and model

Construction materials, thicknesses, and finishes

Manufacturer's performance data

Overall dimensions and required service clearances

Net weight and loading distribution

Pumps

Name of manufacturer

Type and model

Construction materials, thicknesses, and finishes

Rotative speed

Size of suction and discharge nozzles

Overall dimensions and required service clearances

Net weight and loading distribution

Performance curves with the specified operating point clearly identified for each unit, type, and model with capacity in gallons per minute (L/s) as the abscissa and NPSH required and total pump head as the ordinate. The curves shall also indicate pump efficiency and brake horsepower.

Type of coupling

Data on shop painting

Motors

Name of manufacturer

Type and model

Horsepower (kW) rating and service factor

Temperature rise and insulation rating

Full load rotative speed

Type of bearings and method of lubrication

Net weight

Overall dimensions

Efficiency at full, 3/4, and 1/2 loads

Full load current and power factor

Locked rotor current

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting

Parts lists and predicted life of parts subject to wear

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. One mechanical seal for each size and type of pump shall be furnished for the equipment.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces except motors shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment shall be installed on concrete bases at least 6 inches (150 mm) high. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.08 Piping. Unless otherwise indicated herein, piping shall be as specified in Master Specification Section 15060, Miscellaneous Piping and Pipe Assemblies.

2.4.09 Valves. Unless otherwise specified herein, all valves shall be as specified in Master Specification Section 15100, Miscellaneous Valves.

Unless otherwise indicated, 2 inch (50 mm) and smaller valves shall have threaded end connections and 2-1/2 inch (65 mm) and larger valves shall be flanged.

2.4.09.01 Flow Control Valves. Flow control valves shall be Bell & Gossett "Circuit Setter", Taco, or approved equal. Readout kits shall be Bell & Gossett "Model RO-2", Taco “Model 789” , or approved equal.

Flow control valves shall be suitable for a working pressure of 125 psig (862 kPa gauge) at 250°F (121°C). Each flow control valve shall be equipped with readout ports fitted with an integral check valve designed to minimize system fluid loss during the balancing and monitoring process, and shall have a calibrated nameplate to ensure specific settings. Valves shall be located as indicated on the drawings, and shall be of the same size as the pipe in which they are installed. All valves shall be provided with preformed, molded insulation blocks to permit access for balancing and readout without disturbing system insulation.

A readout kit, compatible with the valves furnished, shall be provided as required. The kits shall be complete with one percent accurate, 0 to 100 feet (0 to 180 kPa) range pressure gauge; color coded hoses for low and high pressure connections; shutoff and vent valves; and carrying case. Upon completion of the work, the kit shall be delivered to Owner.

2.4.09.02 Combination Pump Discharge Valves. Combination pump discharge valves shall be Bell & Gossett "Triple Duty Valve", Taco, or approved equal.

Combination pump discharge valves shall be of straight pattern, flanged, with cast iron body and bolt-on bonnet. The valves shall be suitable for a working pressure of 175 psig (1207 kPa gauge) at 250°F (121°C). Each valve shall be equipped with nonslam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment for flow regulation. Each combination pump discharge valve shall be equipped with readout ports fitted with an integral check valve design to minimize the system fluid loss during the balancing and monitoring process. The valves shall be of the same size as the pipe in which they are installed and shall be suitable for use with the readout kits specified in the Flow Control Valves paragraph. The combination pump discharge valve shall be used for balancing service, not for isolation of the pump discharge.

2.4.09.03 Pressure Relief Valves. Pressure relief valves shall be Bell & Gossett "Model 790", or approved equal.

Pressure relief valves shall have a low blowdown differential and shall be designed to relieve system pressure as indicated on the drawings, within the maximum operating limits of the valve. Pressure relief valves shall be ASME rated and shall bear ASME nameplates. The valves shall incorporate fail-safe disc to ensure normal operation under emergency conditions.

2.4.09.04 Pressure Reducing Valves. Pressure reducing valves shall be Bell & Gossett "Model FB38", or approved equal.

Pressure reducing valves shall be diaphragm operated, with a low inlet pressure check valve and inlet strainer. The strainer shall be easily removed without shutting down the system. The valve seat, strainer, and stem shall be removable and shall be fabricated of corrosion-resistant material. The pressure reducing valve shall be set at the pressure indicated on the drawings.

2.4.10 Expansion Tanks. Expansion tanks shall be manufactured by Bell & Gossett "Series B" for bladder type, or “Series D” for diaphragm type, Taco, or approved equal.

The expansion tanks shall be pressurized diaphragm or bladder type. The tanks shall be furnished complete with a charging valve and other connections indicated on the drawings or otherwise required for a complete installation. The tanks shall be constructed of steel in accordance with the ASME Code for Unfired Pressure Vessels for a working pressure of 125 psig (862 kPa gauge) and shall bear ASME stamp. The tanks shall have an exterior coating of universal type primer.

The expansion tanks shall have the dimensions and capacity as required. Tanks oriented vertically shall be provided with an integral base suitable for vertical floor mounting. Tanks oriented horizontally shall be suitable for horizontal ceiling-hung installation.

2.4.11 Air Separators. The air separators shall be Bell & Gossett "Model R", Taco, or approved equal.

Air separators shall be constructed of carbon steel in accordance with ASME Code for Unfired Pressure Vessels for working pressures of 125 psig (862 kPa gauge) and shall bear ASME stamp. The air separator connections shall be of the same size as the pipe in which it is installed, and the air separator performance capacity shall be suitable for the system flow rate. The air separators shall include strainers with 3/16 inch (5 mm) perforations and a free area at least five times the cross sectional area of the connecting pipe. The maximum pressure drop shall not exceed 1 psi (7 kPa) at design flow. The air separators shall have an exterior coating of universal primer.

2.4.12 Air Vents.

2.4.12.01 Manual Air Vents. Manual air vents shall be Bell & Gossett "Model 4V", Taco, or approved equal.

Manual air vents shall have bronze bodies and nonferrous internal parts. The vents shall be manually operated using a screwdriver or thumbscrew.

Manual air vents shall have 1/8 inch (3 mm) discharge connections and 1/2 inch (15 mm) inlet connections. Air vents shall be designed for 150 psig (1034 kPa gauge) working pressure and 225°F (107°C) operating pressure.

2.4.12.02 Automatic Air Vents.

a. Type 1 Vents. Type 1 air vents shall be Bell & Gossett "Model 107A", Taco, or approved equal.

Type 1 air vents shall be float.actuated, non-modulating, high capacity type designed to purge air and provide shutoff at pressures up to 150 psig (1034 kPa gauge) and 250°F (121°C). The vent shall be constructed of cast iron and fitted with AISI Type 313 stainless steel, brass, EPDM, and silicone rubber internal components.

b. Type 2 Vents. Type 2 air vents shall be Bell & Gossett "Model 87", Taco, or approved equal.

Type 2 air vents shall be designed to purge air and to provide shutoff at pressures up to 150 psig (1034 kPa gauge) and 240°F (116°C). The vents shall be constructed of brass and cast iron with nonferrous internals.

2.4.12.03 Air Control Accessories. Other piping specialties shall be provided as indicated on the drawings or as needed for a complete system. Specialties shall be manufactured by the expansion tank manufacturer.

All supports, rods, anchors, and accessories required to properly support the tanks, separators, and specialties shall be provided.

2.4.13 Test Plug. Test plug fittings shall be Sisco "P/T Plugs", or approved equal.

Test plug fittings suitable for pipeline pressure and temperature testing shall be furnished and installed where indicated on the drawings. Test plug fittings shall be 1/2 inch (13 mm) NPT solid brass with dual seal core of neoprene and shall be rated zero leakage to 500 psig (3447 kPa gauge). Each fitting shall be furnished with a marked, color coded cap with gasket and brass cap chain. Fitting body shall be long enough to extend past the insulation on the piping.

In addition, Contractor shall furnish a test kit compatible with the test plug fittings furnished. The test kit shall consist of two thermometers with 1 inch (25 mm) dial faces, pressure gauges with 3-1/2 inch (89 mm) dial faces and gauge adapter. The thermometers shall have ranges of approximately 25°F to 125°F (-4°C to 52°C) and 0°F to 220°F (-17°C to 104°C) and the pressure gauges shall have ranges of approximately 0-60 psig (0-414 kPa gauge) and 0-150 psig (0-1034 kPa gauge). The kit shall include internally padded and fitted carrying case.

2.4.14 Chemical Feed Pot. Chemical feed pots shall be Hydac "By-Pass Chemical Feeder", or approved equal.

Chemical feed pots shall be furnished and installed where indicated on the drawings to feed poly-functional corrosion inhibiting chemical solutions to the water system. The feed pots shall be of steel, with a 5 gallon (23 L) capacity, and shall be suitable for use with water at a pressure of 150 psig (1034 kPa gauge) and a temperature of 210°F (99°C). Each feed pot shall have inlet and outlet connections, a bottom drain connection, and at least 3-1/2 inch (89 mm) fill opening with a fill cap. The feed pot shall be designed so that the fill cap cannot be removed when the chemical feeder is pressurized.

A plastic instruction panel engraved in at least 1/4 inch (6 mm) high black letters on white background shall be mounted adjacent to the feed pot, describing the valve sequence to be used.

2.4.15 Base Mounted Pumps and Accessories. Base mounted water pumps, denoted by the symbols "HWP" for heating water pumps, "CWP" for chilled water pumps, or “CDWP” for condenser water pumps and an identifying number, shall be Bell & Gossett "Series 1510", Taco, or approved equal.

Each base-mounted pump assembly shall consist of a pump, electric motor, coupling, coupling guard, and all other accessories required for proper operation. Pump capacities shall be as indicated in the schedules on the drawings.

Pumps shall be horizontal single stage, end suction, centrifugal type, of back pullout design suitable for being serviced without disturbing piping connections. The pump casings shall be cast iron, with gauge ports at the nozzles and vent and drain ports at the top and bottom of the casing. The impellers shall be bronze, enclosed type, keyed to the shaft. The casing wearing rings and shaft sleeve shall be constructed of bronze. Pump shafts shall be stainless steel. Shaft seals shall be a mechanical type, suitable for continuous operation at temperatures up to 225°F (107°C).

Pumps shall be electric motor driven and shall be direct connected to the drive motor through a flexible coupling. Each pump and motor shall be mounted on a common cast iron or fabricated steel sub-base suitable for installation on a concrete foundation as indicated.

Bearings shall be grease lubricated ball type with an L_{10} Life Rating of at least 40,000 hours at specified operating conditions. Pump motors shall conform to the requirements of the Electric Motors paragraph and shall be suitable for use with the power supply indicated on the schedules.

Heating water pumps shall be suitable for use with 200°F (93°C) water.

2.4.15.01 Suction Diffusers. Suction diffusers shall be furnished and installed for the heating, chilled, and condenser water pumps, as required. Each diffuser unit shall consist of cast iron angle type body with inlet vanes and combination diffuser strainer with 3/16 inch (5 mm) openings for pump protection. The units shall be designed for 175 psig (1207 kPa gauge) working pressure and at least 250°F (121°C) operating temperature. Each unit shall be provided with an adjustable support foot to carry the weight of the suction piping and shall be sized to fit the pump and system piping connections.

2.4.15.02 Flexible Connectors. Flexible connectors shall be Resistoflex "Model R6904", or approved equal.

Flexible connectors shall be furnished and installed for the suction and discharge of each pump and where indicated on the drawings. The connectors shall be multiple arch type with TFE T62 teflon bellows, monel reinforcing rings, control units, and flanged ends. The connectors shall be designed for use with water at a pressure of 100 psig (689 kPa gauge) and a temperature of 250°F (121°C).

2.4.16 Pressure Gauges. Pressure gauges shall be Ashcroft "Duragauge 1279", Weiss Instruments, Inc, or approved equal.

Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.

The dial shall be 4-1/2 inch (114 mm) in diameter with black markings on a white background. The units of measurement shall be indicated on the dial face. The pointer shall span not less than 200 degrees nor more than 270 degrees. The scale shall be so arranged that the normal operating reading is near the midpoint of the range.

Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in Master Specification Section 15091, Miscellaneous Ball Valves.

All stem-mounted gauges shall be provided with 1/2 inch (13 mm) NPT connections.

2.4.17 Thermometers. Thermometers shall be furnished and installed where indicated on the drawings. The thermometer range shall be selected so that when installed and operating, the thermometer will read within the middle two-thirds of the scale range.

Each thermometer shall be furnished with a stainless steel thermowell for installation in steel piping systems or brass thermowell for installation in copper piping systems. The thermowells shall have 3/4 inch (20 mm) NPT thread mounts, a minimum pressure rating of 250 psig (1725 kPa gauge), and a nominal 4 inch (102 mm) insertion length.

2.4.17.01 Dial Type Thermometers. Thermometers shall be Weksler Instruments "Adjust Angle", Ashcroft "Series EI Everyangle", Weiss Instruments, Inc. , or approved equal

Dial type thermometers shall be bimetal type and shall have at least 4-1/2 inch (114 mm) dial with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

Each indicator shall be furnished with an angularly adjustable frame for convenient viewing.

2.4.17.02 Stem Type Thermometers. Stem type thermometers shall be Weksler Instruments "Adjust Angle Thermometer" Weiss Instruments, Inc. "9VU", or approved equal.

Stem type thermometers shall be mercury type and shall have at least a 9 inch (225 mm) scale with black markings on a white background. Each thermometer shall have molded Valox polyester case, acrylic or shatterproof glass front, and angularly adjustable stem for convenient viewing.

2.5 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit.

2.6 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.6.01 Safety Guards. All couplings and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.6.02 Electric Motors. Motors furnished with equipment shall meet the following requirements.

A manufacturer's standard motor may be supplied on packaged equipment, fans, pumps, and heaters, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

Outdoor equipment.

Equipment for installation below grade.

Equipment operating in chemical feed and chemical handling locations.

Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor’S option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof or submersible motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

Below 1/2 hp (0.4 kW).
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

1/2 hp (0.4 kW) and above.
460 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.7 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the lastest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.3.01 Valves. Valves of the types and sizes specified herein shall be furnished and installed where indicated on the drawings and in the schedules and where required for proper operation of the systems. Where valves are furnished as an integral part of the equipment, additional valves serving the same purpose will not be required. Valves shall be installed with their stems horizontal or vertical and above the valve body.

All drain valves shall be 3/4" (19 mm) with hose connection unless otherwise indicated.

Except at circulating pump locations, all 4 inch (100 mm) and larger valves shall be installed in horizontal piping.

Provide all low points in the hydronic water system piping with drain connections.

3.3.02 Air Vents. Manual air vents shall be installed at all high points in the hydronic piping systems and at other locations indicated on the drawings.

Automatic air vents shall be installed in the hydronic piping systems where indicated on the drawings.

3.3.03 Base Mounted Pumps. The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field tests and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15525

DIGESTER HEATING BOILERS

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing and installing digester gas fueled heating water boilers as indicated on the drawings.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

1.2.01 General Equipment Stipulations. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Governing Standards. All work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, and laws and regulations of the state which pertain to such work. In case of conflict between these specifications and any state law or municipal ordinance, the latter shall govern.

All work shall comply with Underwriters' Laboratories safety requirements.

The boiler and burner safety controls shall comply with the following:

ASME Section IV, Boiler and Pressure Vessel Code

Factory Mutual (FM)

Industrial Risk Insurers (IRI)

ASME CSD-1, Controls and Safety Devices for Automatically Fired Boilers.

NFPA 54, National Fuel Gas Code.

Definitions of terms and hydraulic considerations shall be as set forth in the Hydraulic Institute Standards.

1.2.03 Coordination. The Contractor shall assume full responsibility for coordination of the boilers with the heating water system, including verification that all structures, piping, and equipment components are compatible. The Contractor shall start up the system and shall make all necessary adjustments so that the system is placed in proper operating condition.

The drawings indicate the extent and general arrangement of the system. If the Contractor deems any departures from the drawings are necessary, details of such departures and the reasons therefor shall be submitted as soon as practicable to the Engineer for review. No such departures shall be made without the prior written concurrence of the Engineer.

1.2.04 Quality Assurance. The equipment to be furnished under this section shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the products of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Major items of mechanical equipment shall be of the best quality normally used for the purpose in good commercial practice and shall be the products of reputable manufacturers.

Several manufacturers are indicated as acceptable for each item of equipment in these specifications. The Contractor shall be responsible for determining that all equipment supplied for the project is suitable for installation in the space provided, as indicated on the drawings, with adequate operating and maintenance access space.

1.2.05 Elevation. The equipment will be operated at an elevation as required.

1.2.06 Power Supply. Power supply to equipment shall be as required.

1.2.08 Shop Painting. All ferrous metal surfaces of each boiler which are to be insulated shall be shop painted with a universal primer prior to installation of the insulation and protective enclosure. Panel boards and electrical controls shall be painted with black enamel. All other surfaces shall be painted with gray enamel. Heated surfaces shall be painted with heat resistant paint.

1.2.05 Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service as required. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1.3 SUBMITTALS. Complete assembly and installation drawings, together with detailed specifications and data covering material used and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master

Specification Section 01080, Projects Submittals. Device tag numbers indicated on the contract documents shall be referenced on the wiring and schematic diagrams where applicable.

The data and specifications for the boilers shall include, but shall not be limited to, the following:

Boiler

Manufacturer and model.

Performance data.

Dimensions.

Connection sizes and locations.

Approximate weight, wet and dry.

Control panel schematics and layout drawings.

Fuel Train

Valve manufacturer.

Valve materials.

Schematic.

Burner

Manufacturer and model.

Sequencing Control Panel

Schematics and layout drawings

1.3.03 Operation and Maintenance Data and Manuals. When required, adequate operation and maintenance information shall be supplied. Operation and maintenance manuals with Master Specification Section 01160, Training and Operation and Maintenance Manuals shall be submitted in accordance with the submittals section.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND SHIPPING. handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as required.

Spare parts shall be suitably packaged as required. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Each boiler will be used to heat water for digester and building heating. Each boiler will be dual-fueled with automatic switchover capabilities. Primary fuel shall be digester gas with backup fuel as required.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Each boiler shall be designed for the performance and design requirements as required.

2.4 DIGESTER HEATING BOILER.

2.4.01 Fire Tube Boiler. When required, boilers shall be a packaged, horizontal, multi-pass, fire tube, scotch marine type boiler with front and rear gasketed doors or panels to allow access for inspection and cleaning of the tubes and tube sheets. Boilers shall be constructed with water cooled combustion chamber and multi-pass fire tubes with separate tube sheets. Boilers shall be designed to provide a minimum of 5 square feet of heating surface area per rated boiler horsepower. Boilers shall be factory assembled.

2.4.01 Cast Iron Sectional Boiler. The boiler shall be a factory assembled package, cast iron, sectional type. Boilers shall be designed for vertical travel of flue gas. Each section of the boiler shall be manufactured with cast-on heat absorbing studs to transfer heat from the combustion gases to the boiler water. Boilers shall be designed and constructed so that the combustion chamber is completely surrounded by circulating water. Boiler sections shall be fabricated with ground-faced metal-to-metal joints which do not need putty, cement, or other filler. Each boiler shall be equipped with access openings for cleaning the flueways between sections.

Where the boiler physical size precludes the use of a packaged unit and with the written concurrence of Engineer, a field assembled unit will be acceptable. To minimize field assembly work, major components shall be shop assembled to the maximum extent practicable.

Boilers shall be furnished complete with a burner assembly, firing controls, control panel, fuel valve gas trains, electrical wiring, safety equipment, a structural steel base, lifting lugs, and all accessories and appurtenances specified or required for a complete, properly operating installation.

2.4.02 Burner Assembly. The burner shall be capable of operating on digester gas at the conditions as required and shall automatically switch to the secondary fuel. The pilot shall be suitable for operating fuel as required.

2.4.03 Burner Firing Controls. Burner controls shall provide positive control of the fuel supply to the burner and pilot. Burner controls shall be microprocessor based.

Control shall provide at least a 30 second purge of the combustion chamber before ignition of fuel and a 15 second or longer purge after interruption of the fuel supply.

An electronic scanning device shall sense pilot and main burner flame. Upon flame failure, the controls shall automatically interrupt the fuel supply to the pilot and the burner, sound an audible alarm, and light a visual indicator. A manual reset, low water cutoff switch, and a limit thermostat shall also interrupt operation of each unit. An isolated contact in the low water cutoff switch, which shall close on low water level, shall be wired to terminals in the control panel.

Except when flame failure occurs, automatic spark ignition and provisions for automatic restarting after a power failure or momentary interruption of the fuel supply shall be provided.

When required a signal shall be sent to start a boiler pump when a boiler is energized. The boiler shall not fire until flow is confirmed.

Each boiler unit shall be provided with a fuel selector switch with DIGESTER GAS, AUTO, and secondary fuel positions. When the switch is in the DIGESTER GAS or the secondary fuel position, the boiler shall operate on the single fuel indicated. In the AUTO position, priority shall be given for firing on digester gas, with automatic switchover to the secondary fuel on low digester gas supply pressure. The AUTO mode shall not allow automatic return from the secondary fuel firing to digester gas firing until the remote digester discharge gas pressure input contact indicates sufficient digester gas pressure has returned after an adjustable timer has timed out. Time delay shall be set with a timer furnished in the boiler control panel.

Digester gas and the secondary fuel shall be ignited by a proven gas pilot.

The boiler unit shall be provided with pressure regulators, valves, strainers, filters, fuel pump, and controls as required for the use of the specified fuels.

The burner shall be full modulation type. The gas train shall meet code requirements for burner safety controls as required. All materials in contact with digester gas shall be suitable for the gas. Unless otherwise specified, all valve trim in contact with digester gas shall be fabricated of stainless steel or aluminum. All automatic shutoff valves or vent valves shall have stainless steel bodies, hard-faced stainless steel seats, chrome plated stainless steel discs, and Viton seals, and shall be Maxon with trim 5-3. Pressure reducing valves shall have cast iron bodies and shall be Fisher or approved equal.

2.4.04 Air Fan. Each unit shall be equipped with a forced draft air fan sized to supply the air required for proper combustion of the fuel. Fan motor controls shall be interlocked with the automatic ignition system and the two fuel valves to provide the specified purge period prior to ignition and following cessation of ignition of the fuel. Each fan motor shall be suitable for operation with the specified power supply and shall be provided with a suitable starter.

Each unit shall be provided with all devices required to properly purge the combustion chamber and positively control the air volume produced by each fan to ensure proper combustion of the fuel.

2.4.05 Control Panel. An electrical control panel shall be provided and mounted on each boiler unit. A circuit breaker for suitable for the power supply shall be mounted on the control panel. In addition, fan motor starter, burner firing controls, control transformer, ignition transformer, alarm horn, fuel selector switch, lights, and all electrical controls and devices specified herein or otherwise required for proper operation of the equipment shall be mounted on the panel. The complete control panel shall have an interrupting rating of at least 42,000 amperes at 480 volts ac.

All controls shall be housed in NEMA Type 12 enclosures. All external wiring shall be enclosed in conduit.

Isolated contact outputs shall be provided as required. All contacts shall be rated for 5 amperes at 120 volt ac.

All electrical components of each unit shall be factory installed and wired so that only connection of the power supply circuit to the control panel is required during installation of the equipment.

All electrical components of the boiler unit shall be factory installed and wired so that connections of the power supply circuit to the control panel is required during installation of the equipment.

2.4.06 Boiler Trim. Boilers shall be provided with ASME safety relief valve, burner flame observation ports and additional trim items as required.

Observation ports shall be mounted on the front and back sections of the boiler to permit visual inspection of the burner flame.

Boiler pressure relief valves shall be of the side discharge type and shall be piped to the bottom of the unit. The valves shall be set to relieve at the rated boiler ASME working pressure. The valve shall have a discharge capacity equal to or greater than the listed output of the boiler.

2.4.07 Unit Enclosure. Each boiler shall be furnished with insulated heavy gage steel jacket with baked enamel finish and insulated with heavy density fiberglass.

2.5 SEQUENCING PANEL. When required a sequencing panel suitable for operating multiple boilers shall be provided. A loop-powered temperature transmitter, located in the boiler discharge header, shall be provided and shall send a 4-20 mA signal to the panel to allow automatic sequencing of lead/lag boilers and full modulation control of the burners. The control system shall be microprocessor based, pre-engineered and programmed. The sequencing panel shall be powered as required and shall be enclosed in a lockable steel, NEMA 1 enclosure. The panel controls shall be UL and CSA listed.

The panel shall include the following:

ON, OFF, AUTO, STANDBY selector switch for each boiler

Manual/Automatic Lead/Lag rotation switch.

Normally open contact for burner start/stop.

Control power transformer as required.

Burner firing rate controller.

Lead and activated boiler lights.

Ignition start adjustment for each boiler.

Modulation start adjustment for each boiler.

Terminals for accepting discrete signals from remote-mounted emergency shutdown switches.

Terminals for accepting a 4-20 mA signal from remote-mounted digester gas pressure switch.

Terminals for accepting a 4-20 mA signal from remote-mounted temperature transmitter

Temperature setpoint adjustment knob.

Purge timer.

Battery backup.

LED display of actual temperature, setpoint temperature, gain adjustment, and boiler percent modulation.

The lead/lag control of the boilers and modulation of the burner shall be based on the heating water supply temperature. On drop of supply water temperature, the lead boiler shall be energized. Following a time delay to allow the boiler to be fired, the controls shall begin modulating the lead burner upward at a rate proportional to the supply temperature rate of change. When the burner on lead boiler goes to high fire, the first lag boiler shall be energized and controlled similar to the lead boiler. When the burner of the first lag boiler goes to high fire, the second lag boiler shall be energized and controlled similar to the lead boiler. As the supply temperature rises, the modulation of the last boiler on line shall decrease until it gets to its ignition start point. It shall be held at that point until the previous on line boiler burner has been modulated to its ignition start point. The last boiler on line then shall be de-energized.

When the boiler fuel selector switch is in the AUTO position, controls shall be provided for automatic fuel switchover from digester gas to natural gas based on a 4-20 mA signal from a remote pressure transmitter. Priority shall be given to firing on digester gas. As the digester gas pressure decreases to a setpoint, the lag boilers shall be switched to fire on natural gas. If the pressure decreases to a setpoint pressure, the lead boiler shall be switched to fire on natural gas. When the pressure increases above the setpoint pressure, after a time delay, the lead boiler shall be switched back to fire on digester gas. If the pressure continues to increase, the lag boiler shall be switched back to fire on digester gas.

2.6 BOILER FLUE. Boiler flues shall be furnished and installed where indicated on the drawings. The boiler flue systems shall be factory built, laboratory tested and listed by Underwriters' Laboratories, and shall comply with the requirements of NFPA 211. Flue systems shall be designed and installed to be gastight to prevent leakage of combustion products into the building.

The boiler flue should be double walled with a nominal 1-inch air space between the walls. The inner and outer jackets shall be constructed of materials as required. The materials and construction of the modular sections shall be as specified by the terms of the product's UL listing.

Drain tee caps, stack caps, storm collars, and flanged boiler kits shall be provided. Caps shall be constructed of stainless steel materials. The systems shall be designed to compensate for all flue gas inducted thermal expansions. Flues shall be supported where indicated on the drawings and as required by the system’s manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished at locations determined by the flue systems manufacturer. The entire system from each boiler to the termination, including accessories, shall be the product of one manufacturer.

The flue systems shall be installed according to the manufacturer's installation instructions and shall comply with all applicable codes. The flue systems shall be Selkirk Metalbestos "Model PS" or approved equal.

2.4.08 Anchor Bolts. Anchor bolts and nuts shall be furnished as required for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

The bolts shall be at least 3/4 inch (19 mm) in diameter.

Anchor bolts shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2-1/2 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with thickness of approximately 1/2 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be furnished with each anchor bolt.

All anchor bolts, nuts, and washers shall be carbon steel, stainless steel, or galvanized steel, as required.

Anchor Bolts and Nuts

Stainless Steel	AISI Type 316, 316L; Bolts ASTM F593, Alloy Group 2; Nuts ASTM F594, Alloy Group 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.
Flat Washers	ANSI B18.221; of the same material as the bolts and nuts.

Anchor bolts shall be long enough to accommodate at least 1-1/2 inches (38 mm) of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2.7 SHOP TESTING.

2.7.01 Hydrostatic Tests. When required, each boiler shall be hydrostatically pressure tested before shipment in accordance with Section IV of the ASME Boiler and Pressure Vessel Code.

2.7.02 Fire Test. When required and after assembly, each boiler shall be filled and brought to and maintained at operating temperature with the furnished burner using either the primary or secondary fuel specified. In addition, control functional tests shall be performed.

2.7.03 Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

PART 3 - EXECUTION

3.1 INSTALLATION. The equipment shall be installed in accordance with the manufacturer's recommendations, and all work shall be completed in a neat and workmanlike manner. Installation shall provide the required accessibility for adjusting, cleaning, and lubricating working parts; and replacing controls, safety devices, and other control components. Care shall be exercised to ensure that piping stresses are not transmitted to the equipment. Each unit shall be operated, adjusted, and tested after installation as required to ensure proper adjustment and operation of all controls.

Each boiler shall be leveled, plumbed, aligned, and wedged into position to fit connecting piping. The base for each boiler shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. No stresses shall be transmitted to the boiler flanges. After final alignment and bolting, boiler connections shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

3.2 INSTALLATION CHECK. An experienced, competent, and authorized representative of the manufacturer of each item of equipment shall visit the site of the Work for at least 1 days (travel time excluded) and inspect, check, adjust if necessary, start-up, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

Each manufacturer's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3 TRAINING. Training shall be as specified in the Master Specification Section 01160, Training and Operation and Maintenance Manuals. A minimum of 8 hours of training shall be provided to instruct the Owner's operating and maintenance personnel in the actual operation and maintenance of the new boilers once the equipment is in proper working condition.

The training time required shall be separate from the time required in paragraph 3.2.

End of Section

SECTION 15550

HEATING SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heating system equipment, flues, heaters, and associated devices and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations In Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 <u>Equipment Plates</u>. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 <u>Piping</u>. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 <u>Valves</u>. Valves that have been assigned an identification number shall be identified with tags.

1.4 <u>SUBMITTALS</u>.

1.4.01 <u>Drawings and Data</u>. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

<u>Equipment</u>

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Equipment Motors

Name of manufacturer.

Type and model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Bearing types and numbers.

Weight.

Overall dimensions.

Full load amperes, efficiency, and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

Flue piping and fittings shall be factory built, laboratory tested, listed by Underwriters' Laboratories, and shall comply with NFPA 211.

Electric heaters shall be UL listed unless otherwise indicated. Electric duct heaters shall comply with the National Electrical Code.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer'S review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 SPARE PARTS. One burner flame detector and boiler pressure relief valve shall be furnished for the equipment.

Spare parts shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Spare parts shall be delivered to Owner as directed.

Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment capacities shall be as indicated on the schedules. Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as indicated.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be in accordance with Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound, as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 FLUE SYSTEMS. Flues shall be provided for all equipment that exhausts combustible material. Drain tee caps, stack caps, storm collars, and equipment connection kits shall be provided. The systems shall be designed to compensate for all flue gas-induced thermal expansions. Flue system materials and construction shall be in accordance with the vented equipment manufacturer's recommendations and instructions.

2.5.01 Factory Built Flues. Flue systems for gravity vented equipment and vertically vented unit heaters listed for use with "Type B" gas vents shall be Selkirk Metalbestos, "Type B" gas vents, Metal-Fab, or approved equal. The flue systems for power vented equipment shall be Selkirk Metalbestos "Type PS" gas vent, Metal-Fab "Model PIC", or approved equal.

The flue pipe and fittings for vertically power vented unit heaters requiring a 5 inch (125 mm) or smaller flue and gravity vented equipment shall be a "Type B" gas vent. The flue shall be of double wall construction, with a 0.25 inch (6 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.012 inch (0.3 mm) aluminum and the outer jacket of at least 0.018 inch (0.5 mm) galvanized steel. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

The flue pipe and fittings for power vented equipment and power vented unit heaters requiring a 6 inch (150 mm) or larger flue shall be of double wall construction with a nominal 1 inch (25 mm) air space between the walls. The inner gas-carrying pipe shall be constructed of at least 0.035 inch (0.9 mm) AISI Type 304 or Type 316 stainless steel, as required, and the outer jacket of at least 0.025 inch (0.6 mm) aluminum coated steel for interior locations and Type 304 or AISI Type 316 stainless steel, as required, for the portions of the stack exposed to the outdoor environment. The materials and construction of the modular sections shall meet the terms of the product's UL listing.

2.5.02 Metal Flues. The flue pipe and fittings for horizontally power vented unit heaters requiring a 5 inch (125 mm) or smaller flue shall be constructed of at least 24 gage (0.61 mm) thickness galvanized steel and shall be sized and arranged as recommended by the vented equipment manufacturer or as directed by Engineer. The flue system shall include all necessary fittings, hangers, supports, and flashings.

2.6 HEATERS. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2.6.01 Baseboard Heaters. Baseboard heaters, denoted by the symbol "BH" and an identifying number, shall be Chromalox, Electromode, or approved equal. The heater model shall be as indicated.

Baseboard heaters shall be constructed of heavy gage, cold-rolled steel. The heating element shall be an aluminum finned tube, suitable for a maximum operating temperature of 400°F (204°C) in an ambient temperature of 70°F (52°C). Watt density of the element shall not exceed 187 watts per foot (614 w/m). Heaters shall be equipped with a thermal limit control, built-in thermostat, shall be prewired for service connection in boxes of equal dimensions at both ends and shall be suitable for use with the indicated power supply.

2.6.02 Cabinet Heaters. Cabinet heaters, denoted by the symbol "CH" and an identifying number, shall be manufactured by McQuay, Trane, or approved equal. The heater model shall be as indicated.

Cabinet heaters utilizing the required heat source shall be furnished and installed as indicated on the drawings. Cabinet heaters shall be complete with controls and accessories as needed for satisfactory operation. The cabinet heaters shall include a chassis, coil, fan assembly, filter, motor, motor disconnect, and insulation.

Cabinet heaters shall be vertical or horizontal as indicated in the schedules on the drawings with a front discharge grille, a bottom return, and a built-in thermostat. Heater casings shall be of steel construction with a minimum 16 gage (1.52 mm) thickness front panel and 18 gage (1.21 mm) thickness end and top panels. Exposed corners and edges of the cabinet heater shall be rounded. Heater casings shall be insulated, furnished with removable access panels, and shall be finished with lacquer or enamel. Finish color shall be selected by Engineer from the manufacturer's standard line of colors.

The cabinet heater fans shall be direct driven, centrifugal, forward-curved, double-width wheels statically and dynamically balanced. Fan motors shall have integral thermal overload protection and shall be suitable for use with a 120 volt, 60 Hz, single phase power supply. When necessary, factory-mounted transformers shall be provided to step down voltage for the control circuit.

Water coils shall be 5/8 inch (16 mm) OD seamless copper tubes mechanically bonded to aluminum fins. The coils shall be suitable for a working pressure of 300 psig (2069 kPa gauge), shall be factory tested for leaks under water at 300 psig (2069 kPa gauge), and shall be rated for entering water and entering air temperatures as indicated in the heater schedule on the drawings.

Electric heating elements shall be finned tube or open coil as required. The units shall be factory wired with a unit-mounted heat switch, magnetic contactors, a high temperature cutout safety control, and a fan override thermostat.

Cabinet heaters shall be provided with removable 1 inch (25 mm) disposable filters located in front of the heating coil.

2.6.03 Heating Water Convectors. Heating water convectors, denoted by the symbol "C" and an identifying number, shall be Trane, or approved equal. The heater model shall be as indicated.

Convector elements shall be constructed of copper tubes expanded and rolled into cast iron headers. Fins shall have integral collars which space the fins, and shall be bonded to the tube by mechanical expansion of the tube. End supports shall carry the weight of element and shall be designed to fit over header.

The cabinet shall be constructed of 14 gage (1.9 mm) thickness or heavier carbon steel reinforced with channel stiffeners. Fronts shall be secured by quick-opening fasteners.

Convector cabinets shall have a baked enamel finish of a color selected by Engineer from manufacturer's standard colors.

Dampers to reduce heating capacity by up to 70 percent when closed shall be factory mounted on the element.

Convector capacity shall be as indicated in the schedule on the drawings.

Convectors shall have 24 inch (610 mm) high cabinets.

2.6.04 Electric Duct Heaters. Electric duct heaters, denoted by the symbol "EDH" and an identifying number, shall be manufactured by Indeeco, Brasch, or approved equal.

Electric duct heaters shall be furnished and installed where indicated on the drawings.

Electric duct heaters shall be open coil or finned tube, as required, and zero clearance type with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames with 2 inch (50 mm) wide flanges suitable for fastening to the ductwork.

Bushings for open coils shall be ceramic and terminals shall be stainless steel. Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

Heaters shall be completely factory wired and shall be provided with disconnecting backup and safety contactors, transformers, an automatic reset thermal cutout, a manual reset thermal cutout, a disconnect switch, and a differential pressure airflow switch. All interconnecting wiring shall be enclosed in a terminal box fastened to the heaters and oriented as indicated on the drawings. The terminal boxes shall be furnished with double doors.

Contactors shall be 600 volt rated, 3 pole, UL listed, and shall have a life expectancy for 100,000 operations. A built-in industrial dry type 480/120 volt control transformer shall be furnished to carry the full contactor holding coil load. Transformer primary and secondary windings shall be fused. Secondary windings shall have one lead grounded.

The duct heaters shall be furnished with a silicone controlled rectifier (SCR) control unit mounted in the duct heater terminal box. The control unit shall be suitable for the temperature range of 32 to 132°F (0 to 55°C), and shall be a solid-state proportioning controller designed to modulate the heater output from 0 to 100 percent. The duct heaters shall be controlled by a thermostat as indicated on the drawings. The duct heater SCR controller shall be compatible with the signal from the thermostats.

The duct heater output in kW shall be as specified at 460 volts, 60 Hz, 3 phase. The heater elements shall be suitable for operation on 480 volt, 60 Hz, 3 phase power.

2.6.05 Electric Infrared Heaters. Electric infrared heaters, denoted by the symbol "IH" and an identifying number, shall be manufactured by Chromalox, or approved equal. The heater model shall be as indicated.

Electric infrared heaters shall be metal sheathed double element type, with 30 degree symmetrical reflector for a narrow controlled beam pattern.

Reflectors shall be constructed of clear anodized aluminum. The heater housing shall be constructed of 20 gage (0.91 mm) thickness steel finished with neutral gray baked enamel.

The heaters shall be mounted at 30 degrees from horizontal.

Electric infrared heaters shall be UL listed and suitable for use with the power supply indicated in the heater schedule on the drawings. Capacities shall be as indicated in the heater schedule on the drawings.

2.6.06 Electric Unit Heaters. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the drawings.

Electric Unit Heaters (non-explosionproof). Electric unit heaters located in unclassified areas shall be Chromalox "LUH" or "VUH", Brasch, or approved equal. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the drawings to be wall hung, a wall mounting bracket shall be provided.

Electric Unit Heaters (explosionproof). Where indicated in the heater schedule on the drawings to be explosionproof, unit heaters shall be manufactured by Indeeco "Ultra-Safe", Ruffneck, Markel, or approved equal. Explosionproof electric unit heaters shall be of the fan forced type with a heat exchanger, fan and motor assembly, automatic reset thermal cutout, built-in contactor, factory installed three pole disconnect switch in NEMA 7 enclosure, and 24 volt control transformer. The heater shall be suitable for use with the power supply indicated in the heater schedule on the drawings. The heater shall be listed for installation in a Class I, Division 1 or 2, Group D location and shall have an NEC ignition code of T3B or better.

The heater cabinets shall be constructed of a corrosion resistant cabinet fabricated from an epoxy coated 14 gage (1.90 mm) thickness steel with individually adjustable outlet blades. Cabinet fasteners shall be stainless steel.

The heat exchanger shall be an efficient liquid to air design utilizing a copper or steel core with aluminum fins. The heat exchanger shall be provided with a coating suitable for use in a corrosive atmosphere consisting of hydrogen sulfide. The heating elements shall be housed in an inhibited propylene or ethylene-glycol heat transfer fluid that is suitable for temperatures down to -49°F (-45°C). A pressure relief valve shall provide overpressure protection for the heat exchanger.

The fan and motor assembly shall consist of an aluminum fan connected to a explosionproof, permanently lubricated ball bearing type motor with built-in thermal overload protection. The motor shall be prewired to the control enclosure providing for a heater that is suitable for use with a single point power connection.

<u>Electric Unit Heaters (corrosion resistant)</u>. Where indicated on the drawings to be corrosion resistant, unit heaters shall be manufactured by Indeeco "Traid", Chromolox "HDH", or approved equal. Each heater shall include fan and motor assembly, operating and safety controls, and shall be suitable for use with a single point power supply indicated in the schedules on the drawings.

Heater elements shall be Type 304 or 316 stainless steel, fin tubular type, with stainless steel fittings forming a watertight seal between the elements and the junction box. Unit heater fan motors shall be totally enclosed, permanently lubricated ball bearing type designed to resist corrosion and moisture. The fan blades shall be epoxy coated aluminum and the heater housing shall be at least a 20 gage (0.91 mm) Type 304 stainless steel. Where indicated on the drawings to be wall hung, a swivel wall mounting bracket shall be provided.

The controls shall include automatic reset thermal cutout, fan delay relay, built-in control and motor contactors, control transformer, and terminal block all housed in a NEMA 4X enclosure. A pilot light visible on the heater exterior shall indicate heater operation.

2.6.07 Gas Unit Heaters. Gas unit heaters, denoted by the symbol "GUH" and an identifying number, shall be Reznor Model "Venturion FE", Trane, Sterling, or approved equal.

Gas unit heaters shall be furnished and installed where indicated on the drawings. Each heater shall be of the type, size, and capacity indicated in the schedules on the drawings; shall be suitable for use with the gas type and pressure as required; and shall be of a type approved and listed in the AGA Directory of Approved Gas Appliances and Accessories.

Each gas-fired unit heater shall be power vented, horizontal discharge, propeller type, and suitable for two point suspending mounting. The heater burner and heat exchanger shall be constructed of E-3 (AISI Type 409) stainless steel. Each heater shall be furnished with a vent cap.

Each gas unit heater shall be furnished complete with a 24 volt transformer, single-stage gas control with a regulated combination redundant gas valve, a spark-ignited, intermittent safety pilot with electronic flame supervision and all required limit and safety controls. Units larger than 125,000 Btu [132,000 kJ] input shall have two-stage gas controls.

The fan motor shall be suitable for use with a 120 volt, 60 Hz, single phase power supply, and shall be provided with automatic reset thermal overload protection.

2.6.08 Heating Water Unit Heaters. Heating water unit heaters, denoted by the symbol "HUH" and an identifying number, shall be manufactured by Modine, Trane, Armstrong-Hunt, Inc., or approved equal

Heating water unit heaters shall be of the discharge orientation indicated, propeller type and shall be suitable for use with the power supply indicated in the schedules on the drawings. The heating water unit heaters shall be rated for entering water and entering air temperatures as indicated in the schedules on the drawings. The noise level generated by each heater shall be appropriate for the space in which the heater is installed. Efficient air deflectors shall be provided for each heater. Heater casings shall be of sturdy, rigid steel construction and shall be finished with lacquer or enamel. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Heating water unit heater capacities and discharge arrangement shall be as indicated in the schedules on the drawings.

Where indicated in the schedules on the drawings to be explosionproof, unit heaters shall be suitable for installation in an NEC Class I, Division 2, Group D area.

2.6.09 Wall Heaters. Wall heaters, denoted by the symbol "WH" and an identifying number, shall be manufactured by Electromode "Model EWA", Brasch, or approved equal.

Wall heaters shall be downflow type; designed for surface mounting; and shall include an electric heating element, a thermal limit switch, a fan delay switch, a fan and motor assembly, and a built-in thermostat. The heaters shall be suitable for use with the specified power supply and shall have the capacity indicated in the schedules on the drawings.

2.7 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements,, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under the electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.8 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.8.01 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.8.02 Electric Motors. Motors furnished with equipment shall meet the following requirements unless otherwise specified in the motors specification:

> A manufacturer's standard motor may be supplied on packaged equipment, fans, pumps, and heaters, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally

enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40° C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feed and chemical handling locations.

4. Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor'S option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
   115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
   460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase. Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.9 SHOP TESTING. The equipment shall be factory tested. Factory test results shall be delivered to Engineer. Equipment shall not be shipped until Engineer has reviewed the test results and advised Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

2.10 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the lastest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath base plates shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body.

3.3.02 Flues. Flues for all equipment exhausting combustible material shall be installed where indicated on the drawings. Flue gas systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counterflashed to provide a weathertight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

Flues shall be supported where indicated on the drawings and where required by the system manufacturer. Supports, guides, and all appurtenances required for a complete system shall be furnished and installed at locations determined by the flue systems manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

The flue height dimensions indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work.

All vertical flues shall be equipped with a capped tee to serve as a condensate drain. Flues 6 inches (150 mm) and larger shall be equipped with a condensate drain connection.

When power vented equipment is listed as being suitable for use with "Type B" gas vents, "Type B" gas vents may be used when all vent joints are sealed to prevent leakage.

Where metal flues are used, each joint shall be sealed with sealant and/or aluminum or teflon tape suitable for the operating temperatures to prevent leakage. The tape shall be wrapped two full turns around each joint. Where single wall metal flues are used to vent equipment, a double wall flue shall be used outside and shall extend through the wall a minimum of 6 inches (150 mm). The annular space of the double wall flue shall be sealed at the connection point between the double and single wall flues. Single wall flues routed through unconditioned spaces or in locations below 8 feet (2.4 m) above the finished floor shall be insulated to prevent condensation or limit the cold face temperature to 150°F (65°C).

Gas unit heater flues shall be installed with a minimum of 12 inches (300 mm) of straight pipe attached to the venter outlet before the installation of an elbow.

3.3.03 Heaters. The bottom elevation of unit heaters shall be 8 feet (2.4 m) above finished floor unless otherwise indicated.

Gas fired unit heaters with side burner and control access shall have the access located on heater side opposite the wall.

Electric duct heaters shall be installed with a minimum distance of 4 feet (1.2 m) from all ductwork transitions and obstructions on both sides of the heater.

3.4 FIELD QUALITY CONTROL.

3.4.01 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field tests and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

3.2 CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner. Each boiler shall be thoroughly cleaned in accordance with the manufacturer's instructions prior to being placed in service.

End of Section

SECTION 15575

FLUE STACKS, BREECHINGS AND VENTS

PART 1 - GENERAL

1.1 SCOPE. Furnish and install all flue stacks, breechings and vents as shown on the Drawings, schedules and as specified herein.

1.2 RELATED REQUIREMENTS. Section 15855 - Air Handling Units

1.3 SUBMITTALS. Submit, in accordance with Section 01160, the following: Catalog cuts and assembly directions for each type of flue or stack.

1.4 REFERENCE STANDARDS. Underwriters Laboratories (UL).

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

The complete system shall meet all applicable governing codes.

PART 2 - PRODUCTS

2.1 GENERAL. Type H or SS Factory Built Chimney - UL listed for use with residential and commercial buildings when forced venting is not required. The double wall metal chimney shall have an outer casing of aluminum coated steel (0.4 oz/sq ft), an inner casing of Type 430 or equal corrosion resistant stainless steel and a minimum dead air space of 1/2-in. Chimney shall be complete with UL listed support plates, roof thimble and guy wires and other accessories as recommended by the manufacturer for a complete installation as manufactured by Metalbestos or equal.

Type PS - UL listed for use with forced venting equipment (MAUS). The system shall be completely design by the flue manufacturer with accessories required as manufactured by Metalbestos or equal. Outer and inner casings shall be 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION. Flues for all equipment exhausting combustible material shall be installed where indicated on the drawings. Flue gas systems shall be gastight to prevent leakage of combustible products into the building and shall be complete with all fittings, hangers, supports, and flashing necessary for proper installation.

Roof penetrations shall be flashed and counter flashed to provide a weather tight installation. The installation shall include, where necessary, ventilating collars to give proper clearance from floors, ceilings, and roofs constructed of combustible materials.

The flue height dimensions indicated on the drawing are minimum and shall be increased to conform to any local codes which pertain to such work. Flues shall be supported where indicated on the drawings and where required by the system manufacturer. The entire system from the equipment connection to the termination, including accessories, shall be from one manufacturer.

Install all equipment per manufacturer's recommendations.

End of Section

SECTION 15650

REFRIGERATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of refrigerant piping and accessories, condensing units, heat pumps, room air conditioners, packaged air conditioning units, package heat pumps, water chillers, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for functions and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein as indicated in the Contract Documents, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15.

Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1, unless otherwise indicated on the drawings.

Capacity ratings for condensing units, heat pumps, packaged air conditioning units, and packaged heat pumps with capacities less than 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 210/240. For condensing units, heat pumps, packaged air conditioning units over 135,000 BTUH (39 kW) the capacity ratings shall be in accordance with ARI Standard 360. Capacity ratings for packaged heat pumps with capacities over 135,000 BTUH (39 kW) shall be in accordance with ARI Standard 340.

Water chiller construction, ratings, and testing shall conform to the requirements of ANSI/ARI 590.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in the schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, and valves denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Air Cooled Condensing Units/Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity and saturated suction temperature at specified conditions.

Equipment efficiency ratings.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Room Air Conditioners

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Certified performance data and ratings.

Capacity at specified conditions.

Overall dimensions and required clearances.

Wiring diagrams and electrical requirements.

Net weight.

Information on local equipment manufacturers' representatives.

Packaged Air Conditioning Units/Packaged Heat Pumps

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Water Chillers

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Certified performance data and ratings.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Information on local equipment manufacturers' representatives.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Bearing types and numbers.

Weight.

Overall dimensions.

Full load amperes, efficiency, and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied and shall be submitted in accordance with the Master Specification Section 01160, Training and Operation and Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. One complete change of lubricating oil and two sets of air filters shall be furnished for the equipment.

Extra materials shall be packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as required.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates will be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.4.08 Refrigerant Piping and Accessories. Refrigerant piping shall conform to Master Specification Section 15070, Copper Tubing and Accessories. Piping shall be supported as specified in Master Specification Section 15140, Pipe Supports. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.

The refrigerant piping size and arrangement shall be in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and sound transmission to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform oil return to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute (5 m/s) in vertical risers with upward gas flow and 500 feet per minute (2.5 m/s) in horizontal piping. The full load pressure drop should not exceed 3 psi (20 kPa) or 2°F (1°C) change in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute (20 m/s). The liquid lines shall be sized to limit the pressure loss to an equivalent of 2°F (1°C) of temperature change and a maximum liquid line velocity of 360 feet per minute (1.8 m/s).

2.5 EQUIPMENT.

2.5.01 Condensing Units/ Heat Pumps. Condensing units, denoted by the symbol "CU" and an identifying number and heat pumps denoted by the symbol "HP" and an identifying number, shall be furnished and installed where indicated on the drawings. Each unit shall consist of compressor(s), condenser coil, condenser fan(s) and motor(s), starters, and all controls necessary for proper operation. Condensing units and heat pumps shall be manufactured by Trane, Carrier, McQuay, York, or approved equal.

2.5.01.01 Performance and Design Requirements. Each unit shall be completely factory assembled and tested, piped, internally wired, and shipped in one piece. Condensing units and heat pumps shall be selected to satisfy the cooling and cooling/heating requirements of the air handling unit being served. A 2°F (1°C) suction temperature difference for piping losses shall be allowed between the condensing unit or heat pump and the air handling unit when in the cooling mode.

As required, condensing units and heat pumps shall be capable of satisfactory operation in the cooling mode at the minimum ambient air temperature indicated. When required to operate in the cooling mode at a lower temperature than the factory standard, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F (-18°C) consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature. Heat pumps shall be capable of operating satisfactorily at an ambient air temperature of 0°F (-18°C) in the heating mode.

The condensing units and heat pumps shall be designed to operate on the power supply as indicated on the drawings.

2.5.01.02 Casing. The unit casing shall be of weatherproof design, constructed of heavy gage galvanized or zinc-coated steel, and reinforced and braced for maximum rigidity. All bracing and reinforcing members shall be integral to each unit. The casing shall be given a factory-applied coat of rust-inhibitive universal primer, followed by the manufacturer's standard baked enamel finish. Fasteners shall be stainless steel or coated for corrosion protection. Each unit shall have removable panels or access doors for access to all components and connections. Drainage holes shall be located in the base section for moisture removal. The unit shall be supported above the mounting surface with base rails or feet.

2.5.01.03 Outdoor Coils. Outdoor coils shall be of the air-cooled, finned tube type with liquid accumulator and integral subcoolers. The coils shall be constructed of 3/8 inch (10 mm) OD seamless copper tubing with aluminum fins securely bonded to the surface. Coils shall be factory leak and pressure tested at 425 psig (2930 kPa gauge) and then completely dehydrated and sealed with a holding charge of nitrogen or refrigerant. The coils shall be protected from hail damage by louvered metal grilles or on units 5 tons or less, corrosion resistant wire maybe used.

2.5.01.04 Fans and Motors. Outdoor fans shall be vertical discharge, direct-driven propeller type, and shall be statically and dynamically balanced. Fan guards shall be located on the discharge of each fan. Fan motors shall be TEFC suitable for outdoor installation and shall have permanently lubricated ball bearings and built-in overload protection.

2.5.01.05 Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Where the compressors are located outside the cabinet, grilles shall be installed over the openings to protect the compressor area.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. The minimum number of capacity step reductions shall be as required. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2.5.01.06 Refrigerant Circuit and Accessories. Each unit shall be completely factory assembled, tested, and fully charged with Refrigerant-22 and compressor oil. Each refrigerant circuit shall be equipped with filter-dryer and multiuse liquid and gas line valves. The multiuse valves shall be constructed of brass with service pressure gauge ports. For condensing units and heat pumps larger than 20 tons (70.3 kW), factory mounted suction and discharge pressure gauges shall be provided. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

Heat pumps shall be provided with reversing valve, flow control check valve, and solid state defrost control system. The defrost system shall be a time and temperature initiated system that activates in response to a temperature sensing element mounted at the outdoor coil.

A hot gas bypass kit, including but not limited to a solenoid valve and hot gas bypass valve shall be provided for each condensing unit larger than 5 tons (17.5 kW). For condensing units larger than 20 tons (70.3 kW), the kits shall be factory installed. For condensing units smaller than 20 tons (70.3 kW), the kit maybe field installed.

2.5.01.07 Controls. Condensing units and heat pumps shall be completely factory wired for a single point power supply connection. All wiring shall be installed in accordance with the National Electrical Code.

Condensing units and heat pumps 5 tons (17.5 kW) or less shall be provided with factory wired control panel containing magnetic contactors, relays, and control power transformer. Units larger than 5 tons (17.5 kW) shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor and outdoor fan motors and internal volt control power transformer.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat, supply voltage terminal points for remotely located refrigerant solenoid valves, and terminal points to energize remote condensing unit and heat pump indicating lights.

An electrically separate, normally open contact shall be furnished to actuate remote indication of unit shutdown in the event any of the safety interlocks automatically shuts down the unit. The contact shall close on any safety condition except low refrigerant suction pressure.

A thermostat for operation of the unit shall be furnished and installed as indicated on the drawings. The thermostat type shall be as needed to perform the sequence of operation as indicated on the drawings.

The thermostat shall be a programmable or a nonprogrammable heating and cooling type with automatic changeover. The number of stages shall be suitable for the unit control and operation. The thermostat shall have a range of approximately 50 to 90°F (10 to 32°C) with at least a 5°F (3°C) deadband between heating and cooling. The thermostat shall have a subbase to control system and fan operation.

2.5.02 Room Air Conditioner. A room air conditioner denoted by the symbol "RAC" and an identifying number, shall be furnished and installed where indicated on the drawings. The unit manufacturer and model number shall be as indicated.

The unit shall be complete with hermetic motor-compressor, evaporator coil, condenser coil, fan motor, evaporator blower and condensing fan, drain pan, built-in thermostat, and all other necessary operating and safety controls. The slide-out chassis shall be mounted in a heavy gage galvanized steel cabinet. The unit shall provide positive exhaust and ventilation and shall have easily removable, washable filter. The unit shall be designed to operate on the power supply as indicated on the drawings.

2.5.03 Packaged Air Conditioning /Heat Pump Units. Packaged air conditioning units, denoted by the symbol "PAC" and an identifying number, and packaged heat pumps denoted by the symbol "PHP" and an identifying number shall be furnished and installed where indicated on the drawings. Each unit shall be designed for outdoor installation on a full perimeter curb or equipment pad as indicated on the drawings. The packaged air conditioning unit shall be manufactured by Trane, Carrier, McQuay, York, or approved equal.

2.5.03.01 Performance and Design Requirements. The units shall be completely factory assembled and tested, piped, internally wired, fully charged with Refrigerant-22 and compressor oil, and shipped in one piece. The unit shall be designed for direct expansion cooling and configured for heating type indicated. The unit shall be suitable for the power supply and shall have the capacities indicated on the drawings.

The refrigeration system shall be capable of satisfactory operation at outdoor ambient air temperatures of 50°F (10°C) in the cooling mode and for heat pumps, 0°F (-18°C) in the heating mode. When required to operate in the cooling mode at a lower temperature than the factory standard, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0°F (-18°C) consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature.

2.5.03.02 Casing. The unit casing shall be of weatherproof design and shall be constructed of 20 gage (0.91 mm) or heavier zinc-coated steel. The casing shall be properly reinforced and braced for maximum rigidity. The casing shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard baked enamel finish. Interior surfaces of exterior casing members in contact with the airstream shall have one inch (25mm) thick, one pound (454 kg) density, insulation coated on the air side. Aluminum foil-faced glass fiber insulation shall be used in gas fired heating sections. Hinged, insulated, neoprene gasketed access doors or removable panels shall be provided to permit easy inspection and maintenance. Removable insulated access panels shall have aluminum or steel covering on the interior to protect the insulation. The unit base shall be a one-piece, welded assembly with suitable roof curb sealing gasket and curb overhang for water runoff. Drains shall be provided to accommodate outdoor coil runoff.

Where an economizer package is not specified, a manually set air damper shall be furnished to provide the indicated outside air volume.

2.5.03.03 Indoor Coil Section. The indoor coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory leak tested underwater at 200 psig (1380 kPa gauge). The coil shall be provided with expansion device or valve, filter-dryer, and moisture indicator. The indoor coil section shall have fully insulated, sloped drain pan extending under the entire coil section and extending sufficiently past the coil to capture and collect any condensate carryover that may be produced when the unit is operating within the specified operating conditions.

2.5.03.04 Heating Sections. When indicated on the drawings, the unit shall have an electric heating coil, gas heating section, or auxiliary electric heating coil. Electric heater coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code. The heating coil shall have the minimum number of stages indicated in the schedules on the drawings.

Gas-fired heating sections shall be completely factory assembled and wired integral within the unit. When located upstream of the cooling coil, the heating section shall be AGA design certified specifically for outdoor applications upstream of a refrigerant cooling coil. The heat exchanger shall be of constructed of minimum 20 gage (0.91mm) aluminized steel. The burner shall be induced or forced draft type with pressure regulator, redundant main gas valve, manual shutoff valve, and intermittent spark ignition. A flame sensing device and high limit safety controls shall be provided. The number of heating stages shall be as indicated in the schedules on the drawings.

The unit shall be supplied with natural gas having a calorific value of approximately 1000 Btu per cubic foot (37 MJ/m^3) at an inlet pressure as required.

2.5.03.05 Filters. Filters shall be mounted integral within the packaged air conditioning or heat pump unit and shall be 2 inches (50 mm) thick. Hinged access doors shall be provided. Filters shall conform to the requirements in Master Specification Section 15880, Air Distribution Systems.

2.5.03.06 Fans and Motors. The indoor supply fan shall be forward-curved, multiblade, centrifugal type and shall be statically and dynamically balanced by the fan manufacturer. The fan shall have die-formed, streamlined inlets and the scroll shall be constructed of steel with all seams sealed airtight. The fan shall have steel shafts operating in self-aligning, grease lubricated ball bearings.

Units 5 tons (17.5 kW) and smaller shall have direct or belt driven fans. Where direct driven fans are used, the fan shall have multiple speeds to allow for airflow adjustment. Units greater than 5 tons (17.5 kW) shall have V-belt drive with adjustable sheaves and shall be designed for 50 percent overload. The supply fan motor shall conform to the requirements of the Motors and Motor Controls paragraph. Vibration isolators shall be provided for the fan assembly and motor assembly.

Static pressure values indicated on the drawings are external to the complete unit. Internal coil(s), dampers, filters and fan housing losses are not included. A filter allowance of 0.35 inch water column (0.087 kPa) shall be used for 2 inch (50 mm) pleated filter losses.

The outdoor fans shall be direct drive, vertical discharge, propeller type with aluminum blades. Fan motors shall be weatherproof with permanently lubricated ball bearings and built-in thermal overload protection. A corrosion resistant wire guard shall be installed over the fan opening.

2.5.03.07 Compressors. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Each packaged air conditioning or heat pump unit shall have a minimum number of capacity reduction steps as indicated in the schedules on the drawings.

Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.

Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

2.5.03.08 Refrigerant Circuit. The factory sealed refrigerant system shall consist of compressors, outdoor coils, indoors coils, expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, refrigerant piping, and a full operating charge of refrigerant. Service gauge connections shall be furnished on the suction, discharge, and liquid lines. Units with multiple compressors shall have multiple circuits with separate expansion device, refrigerant dryer, reversing valves for heat pump units, accumulators, compressor, and refrigerant charge. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.

2.5.03.09 Outdoor Coil. The outdoor coil shall be of the air-cooled integral finned tube type. The coil shall be constructed of copper tubes with aluminum fins permanently and securely bonded to the tubes. The coil shall be factory leak and pressure tested. The coils shall be protected with hail guards.

2.5.03.10 Accessories. Where indicated on the drawings, the packaged unit shall be provided with economizer cycle to automatically utilize up to 100 percent of outside air for cooling. The economizer shall be controlled as required, and shall modulate return and outside air dampers to maintain proper discharge temperature into the conditioned space. The dampers shall be equipped with automatic lockout when the outside air temperature is too high for proper cooling, and shall have adjustable minimum position control. The damper motor shall be spring return and shall operate to close the outside damper during shutdown. A means for 100 percent relief of the return air shall be provided unless otherwise noted.

Where indicated on the drawings, hot gas bypass shall be installed to provide reduced capacity control.

When required, packaged units shall be furnished with a roof mounting curb. The curb shall be constructed of at least 16 gage (1.52 mm) zinc-coated steel with nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply and return air openings. The curb shall be a minimum of 16 inches (405 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.5.03.11 Controls. Each packaged unit shall be completely factory wired and shall have a single point power connection and unit mounted disconnect switch. All wiring shall be installed in accordance with the National Electrical Code.

The unit shall be provided with remote control and monitoring panel consisting of system operation switches and signal lights. The signal lights shall be for power, outage, dirty filters, and reset relay.

Packaged units shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor, outdoor fan, and indoor fan motors, and internal volt control power transformer.

Defrost controls, electronic timed initiated and temperature terminated with field adjustable timer shall be provided for all packaged heat pumps. When auxiliary electric heating is provided, a factory installed emergency heat package shall be provided. When heating is locked out, the auxiliary heat shall be activated as necessary.

Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously.

All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat; terminal points to energize remote dirty filter, heating mode, cooling mode, and service indicating lights; and terminal points to de-energize the unit upon detection of smoke.

A thermostat for operation of the unit shall be furnished and installed as indicated and located where indicated on the drawings.

The thermostat shall be a manual changeover, automatic changeover, or programmable heating and cooling type. The number of stages shall be suitable for the unit control and operation. The thermostat shall have a range of approximately 50° to 90°F (10° to 32°C) with at least a 5°F (3°C) deadband between heating and cooling. The thermostat shall have a subbase to control system and fan operation.

2.5.04 Water Chillers. Packaged water chillers, denoted by the symbol "WC" and an identifying number, shall be furnished and installed where indicated on the drawings. The water chillers shall be manufactured by McQuay, Carrier, Trane, or approved equal.

2.5.04.01 Performance and Design Requirements. The package chillers shall consist of compressors, evaporator, shell and tube type condenser, thermal expansion valve, refrigerant accessories, and control panel. The chillers shall be completely factory assembled, wired, factory run tested. The complete assembly shall be mounted on a structural steel base.

The water chiller capacity and the evaporator and condenser fouling factors shall be as indicated in the schedules on the drawings. The capacity indicated is a minimum capacity. Units furnished shall be provided with sufficient capacities to account for tolerances due to manufacturing and testing variations. The minimum coefficient of performance (COP) and integrated part-load value (IPLV) shall meet the latest version of the ASHRAE Standard 90.1.

2.5.04.02 Compressors. Each compressor shall be a reciprocating, direct drive, 1750 rpm, semi-hermetic type suitable for use with Refrigerant-22. The compressors shall be equipped with suction and discharge service valves, hot gas muffler, internal relief valves, double-mesh suction inlet screens, and shall be mounted on spring isolators.

Each compressor shall be furnished with forced feed lubrication system complete with reversible, positive displacement oil pump, oil charging valve, oil level sight glass, and oil filter arranged to provide lubrication during startup, normal, and stopping operations. A crankcase heater shall be provided to prevent dilution of the oil by the refrigerant.

The compressor motor shall be suction gas cooled with solid state motor protector and shall have automatic capacity reduction equipment consisting of suction valve unloaders. As required, the minimum number of capacity step reductions shall be as indicated. Each compressor shall start unloaded.

2.5.04.03 Evaporators. The evaporators shall be shell and tube type with removable heads, internal water baffles, and integrally finned seamless copper tubes expanded into tube sheets. Each tube shall be individually replaceable. The evaporators shall be constructed, tested, and stamped in accordance with the ASME Code for Unfired Pressure Vessels for a refrigerant side working pressure of 225 psig (1550 kPa gauge) and a water side working pressure of 150 psig (1035 kPa gauge), and shall be insulated with 3/4 inch (19 mm) flexible closed cell plastic insulation.

2.5.04.04 Condensers. The condensers shall be shell and tube design with high strength steel shell and seamless, integral fin, copper tubes expanded into tube sheets. The condensers shall be constructed, tested, and stamped in accordance with the ASME Code for Unfired Pressure Vessels for a refrigerant side working pressure of 300 psig (2070 kPa gauge) and a water side working pressure of 150 psig (1035 kPa gauge). Each condenser shall have an integral subcooler circuit and a safety pressure relief.

Where potable water is supplied to the condenser, the condenser construction shall be suitable for use with potable water. Tubes shall be constructed of 90/10 cuppro-nickel, tube sheets shall be monel clad, and the heads epoxy coated.

2.5.04.05 Refrigerant Circuit. Each package chiller shall have a liquid line shutoff valve, filter dryer, liquid line sight glass with moisture indicator, liquid line solenoid valve, thermal expansion valve, compressor discharge service valve, insulated suction line, pressure relief device, and a charging valve. Chillers which have multiple compressors shall use independent refrigerant circuits. Each circuit shall be permitted to be shutdown without impacting the operation of the other circuit. The chillers shall be pressure tested, evacuated, and given full operating charge of Refrigerant-22 at the factory.

2.5.04.06 Accessories. The compressor shall be enclosed by a sound attenuator consisting of an acoustically lined compartment of 16 gage (1.52 mm) metal with one inch (25mm) of 1-1/2 pound (24 kg/m^3) density glass fiber lining.

When required, the chiller shall have hot gas bypass permitting the unit to operate down to 10 percent of the full load capacity. The hot gas bypass shall include hot gas bypass valve, solenoid valve, manual shutoff valve and all required controls. Units with hot gas bypass need not include a lead-lag compressor control.

Rubber-in-shear or spring isolators shall be provided for installation beneath the unit frame.

Each chiller shall be fitted with a gauge package consisting of high and low side refrigerant pressure gauges per refrigerant circuit and oil pressure gauge per compressor. A shutoff valve shall be included for each gauge.

Each chiller shall be provided with an evaporator and condenser water flow switches.

Condenser water regulating valves shall be provided by the chiller manufacturer.

2.5.04.07 Controls. A factory-built control panel with hinged access doors shall be mounted on each chiller. The control panel shall contain provisions for single point power connection, non-fused disconnect switch, starters, safety controls, control power transformer, fused control circuit, and terminal strips. Each compressor shall be provided with starter and motor contactors, non-recycling three phase compressor overload protection, and current overload protection. The starter type shall be as required. All accessories provided with the unit as specified herein and indicated in the sequence of operations shall be prewired for power and control to the unit control panel by the unit manufacturer.

A standard control package, or a microprocessor based interface shall be provided, as required.

As indicated, a factory-built sequence control panel shall be provided to control a multiple chiller system as set forth in the Sequence of Operations on the drawings.

2.5.04.07.01 Standard Control Package. The control panel shall have lights to indicate the status of all unit safeties, power, and compressor staging. An individual light shall be provided for each safety condition. An electrically separate, normally open contact shall be furnished to actuate a remove indication in the event any of the safety interlocks, except low refrigerant suction pressure, automatically shuts down the unit.

Each chiller circuit shall have recycling pump-down control, high pressure control, low pressure control, motor protector with oil pressure cutout, and low temperature cutout. An anti-recycle timer and timed periodic pumpout shall be provided to prevent rapid compressor cycling and liquid slugging. Except for units with hot gas bypass on one refrigerant circuit, units with multiple compressors shall have lead-lag compressor control.

A chilled water temperature controller and sensor set to maintain a nominal 45°F (7°C) leaving chilled water temperature shall cycle the compressors and activate the cylinder unloaders in response to the supply/return chilled water temperature.

2.5.04.07.02 Microprocessor Based Interface. The control panel shall contain a microprocessor based interface system capable of controlling the unit operation, setting control parameters, and monitoring alarm status. The microprocessor control system shall be pre-programmed with English language display, non-volatile memory, and shall be capable of displaying alarm diagnostics. Entering/leaving evaporator temperatures, entering/leaving condenser water temperatures, suction temperature of each circuit, suction pressure, discharge pressure, and alarm status shall be displayed using the interface system.

2.6 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.7 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.7.01 Adjustable Frequency Drives. Adjustable frequency drives shall be provided as indicated on the drawings and shall be coordinated with the requirements of the associated equipment. The equipment manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

Adjustable frequency drives shall be as covered in Master Specification Section 16150, Variable Frequency Drives.

2.7.02 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor.

2.7.03 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm thick) or thicker galvanized or aluminum-clad sheet steel or from ½ inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.7.04 Electric Motors. Motors furnished with equipment shall meet the following requirements.

> A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

Outdoor equipment.

Equipment for installation below grade.

Equipment operating in chemical feed and chemical handling locations.

Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor’s option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

Motors shall be rated as follows:

<u>Below 1/2 hp (0.4 kW)</u>.
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

<u>½ hp (0.4 kW) and above</u>.
460 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

Motors to be used with adjustable frequency drives shall be rated for inverted service.

2.8 <u>SHOP TESTING</u>. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

2.9 <u>BALANCE</u>. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the lastest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Surface Preparation. All surfaces to be painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath the baseplate shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Valves. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the miscellaneous valve sections.

3.3.02 Refrigerant Piping and Accessories. The refrigerant piping shall be sized and arranged in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and transmission of sound to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform return of oil to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute (5 m/sec) in vertical risers with upward gas flow and 500 feet per minute (2.5 m/s) in horizontal piping. The full load pressure drop should not exceed 3 psi (20 kPa) or 2°F (1°C) change in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute (20 m/s). The liquid lines shall be sized to limit the pressure loss to the equivalent of 2°F (1°C) of temperature change and a maximum liquid line velocity of 360 feet per minute (1.8 m/s). A piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

3.3.03 Condensing Units/Heat Pumps. The condensing units and heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the drawings.

After the refrigerant system has been tested, the system shall be fully charged with refrigerant 22 and compressor oil.

3.3.04 Packaged Air Conditioning Units/Packaged Heat Pumps. The packaged air conditioning units and packaged heat pumps shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the drawings.

3.3.05 Water Chillers. Packaged water chillers shall be installed in accordance with the manufacturer's installation instructions. Each chiller shall be installed level on vibration isolators firmly anchored to the concrete equipment base. Piping around chiller shall be arranged for easy dismantling and permit tube cleaning.

The chiller safety relief valve shall be piped to outdoors at a location not less than 15 feet (4.6 m) above grade and not less than 20 feet (6.1 m) from any operable window, ventilation opening, or exit. The discharge termination shall be arranged to prevent direct spray on personnel in vicinity and foreign material from entering the discharge piping. The pipe size shall be as recommended by the water chiller manufacturer.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

3.4.03 Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5. CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

End of Section

SECTION 15755

HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of heat exchangers for the locations and services as indicated.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts and Tools shall apply to all equipment provided under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet (1 m) of clear access space shall be provided on all sides of the unit.

1.2.03 Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

1.2.04 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow convenient collection of waste oil in containers from the operating area or platform without removing the unit from its normal installed position.

1.2.05 Abbreviations. Reference to standards and organizations herein shall be as indicated by the following designations.

AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
NEMA	National Electrical Manufacturers Association
NPT	National Pipe Thread
UL	Underwriters' Laboratories
USS	United States Standard

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals. The data and specifications for each unit shall include, but shall not be limited to, the following:

Equipment drawings showing dimensions, connection sizes and locations, and maintenance clearances.

Unit shipping and operation weights.

Heat transfer capacity rating.

Design conditions of heat transfer capacity rating.

Heat transfer surface area.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.5 SPARE PARTS. A matched set of V-belts and matched set of gaskets shall be provided.

Spare parts shall be suitably packaged with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The heat exchangers shall be suitable for the service conditions as indicated.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Heat exchangers and accessories shall be designed for the performance and design requirements as indicated.

2.3 MATERIALS.

Plate and Frame Heat Exchangers	
Plates	As required.
Guide Bars	Stainless or chrome plated steel.
Frame	Carbon steel.
Tie Bolts	Stainless or zinc plated steel.
Gaskets	One-piece molded elastomer suitable for the specified service.
Cover	Galvanized steel, 14 gage (1.89 mm) minimum thickness.
Air-Cooled Heat Exchangers	
Frame	Carbon steel, galvanized.
Core	Continuous aluminum plate fins mechanically bonded to tubes.
Fan Impeller	Aluminum; air foil design.
Shell and Tube Heat Exchangers	
Shell	Fabricated steel.
Tubes	Inhibited Admiralty
Tube Sheets	90-10 Cu Ni
Rust-Preventive Compound	As recommended by manufacturer.

2.4 CONSTRUCTION. Connections 2-1/2 inch (63 mm) and larger shall be ANSI B16.5, Class 150 flanges. Connections 2 inch (50 mm) and smaller shall be NPT threaded.

Each unit shall be provided with provisions for lifting.

Each exchanger shall be designed to ASME Section VIII requirements. The heat exchanger shall bear the ASME stamp for unfired pressure vessels.

2.5 PLATE AND FRAME EXCHANGERS. Plate and frame type heat exchangers shall be constructed with a frame suitable for mounting on a concrete pad foundation. Plates shall be corrugated and shall include flow directors which shall evenly distribute the fluids over the exchange surface. Each plate shall have provisions for support and proper alignment of the members. Plates shall be of standard size of the manufacturer and replaceable with minimum disassembly of the unit. Each heat exchanger shall be provided with a protective sheet metal cover over the plate sections which can be easily removed without disturbing the piping connections. Heat exchangers shall be shop assembled with all openings sealed prior to shipment.

2.6 AIR-COOLED EXCHANGERS. Air-cooled heat exchangers shall consist of the heat exchange core section complete with fan and structural frame suitable for mounting on a concrete pad foundation. Manifolds shall be removable for access to and cleaning of tubes. Core shall be pitched to a drain connection with shutoff valve.

Fans shall be forced draft driven by an electric drive motor.

2.7 SHELL AND TUBE EXCHANGERS. Shell and tube type heat exchangers shall be horizontal tube type with removable tube bundle. Exchangers shall be constructed with fabricated channels at each end. Channels shall have flanged and bolted covers which can be removed without disturbing any piping connections

Shells shall be of welded construction and include provisions for expansion of one of the tube sheets and channels if required by the manufacturer's design for the specified conditions. Shells shall have two supports suitable for mounting on concrete pad foundations. All necessary connections shall be provided for piping, vents, drains and instruments.

Tubes shall be rolled into the tube sheets and shall be adequately supported to prevent sagging or vibration. The method of expanding the tubes shall be such as to not change the size of the tube sheet opening. The tube bundle supports shall be arranged as baffles to obtain the most effective distribution of the fluid above and around the entire tube bundle.

Tube sheets shall be of adequate thickness for the design pressures and physical size of the exchanger with a minimum thickness of one inch. Tube holes shall be arranged on a triangular pitch. Tube hole edges shall be chamfered on the shell side and each hole shall be provided with a minimum of two grooves. The bridge between tube holes shall be not less than 3/16 inch (5 mm) nominal.

2.8 ACCESSORIES.

2.8.01 Relief Valves. A relief valve shall be furnished on each liquid side of each exchanger. Relief valves shall have manual lifting levers and shall be capable of protecting the exchanger from overpressure in the event the exchanger is operated with closed isolation valves.

2.8.02 Temperature Switches. Temperature switches shall be provided in the air-cooled exchanger manifold for control of the fan. Switches shall close on rising temperature to start the fan motor. Switch contacts shall be rated at least 10 amperes at 120 volts ac.

2.8.03 Anchor Bolts. Anchor bolts and nuts shall be furnished as required for each item of equipment. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed.

The bolts shall be at least 3/4 inch (19 mm) in diameter.

Anchor bolts shall be accurately located and centered in pipe sleeves having an inside diameter approximately 2-1/2 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with thickness of approximately 1/2 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be furnished with each anchor bolt.

All anchor bolts, nuts, and washers shall be carbon steel, stainless steel, or galvanized steel.

Anchor Bolts and Nuts

Carbon Steel	ASTM A307 or ASTM A36.

Stainless Steel

AISI Type 304, 305, 384, 304L	Bolts ASTM F593, Alloy Group 1; Nuts ASTM F594, Alloy Group 1.
AISI Type 316, 316L	Bolts ASTM F593, Alloy Group 2; Nuts ASTM F594, Alloy Group 2.
Galvanized Steel	Carbon steel bolts and nuts; hot-dip galvanized, ASTM A153 and A385.
Flat Washers	ANSI B18.22.1; of the same material as the bolts and nuts.

Anchor bolts shall be long enough to accommodate at least 1-1/2 inches (38 mm) of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

Anti-seize compound will be applied to the threads of all stainless steel bolts before assembly.

2.9 DRIVE UNITS Each fan shall be driven by an electric motor. Drive units shall be designed for 24 hour continuous service.

2.9.01 Belt Drive When belt drives are required by the manufacturer's design, V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 4 to 1. Each belt drive shall include a sliding base or other suitable means of tension adjustment.

2.9.02 Safety Guards All belt drives, fan blades, couplings, and other moving or rotating parts of the units shall be covered on all sides by a safety guard, fabricated from 16 USS gage (1.52 mm thick) or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal and shall be furnished complete with all necessary supports and accessories. Supports and accessories, including bolts, shall be galvanized. Safety guards in outdoor locations shall be designed to keep out rain and dripping water.

2.9.03 Electric Motors. The electric motors shall be as indicated in Master Specification Section 16220, General Purpose Induction Motors.

2.10 SHOP COATING. All steel and iron surfaces shall be protected by suitable shop-applied coatings. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment with coatings suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for coating. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for being top-coated in the field with a universal primer and aliphatic polyurethane system.

Machined, polished, and nonferrous surfaces shall be coated with rust-preventive compound.

All other surfaces to be coated after installation shall be prepared for coating as recommended by the coating manufacturer for the intended service, and then shop coated with one or more coats of the specified shop primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

2.11 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price for the number of days and round trips to the site as required.

3.2.02 Installation Supervision. The equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the contract price.

Manufacturers' installation supervisor shall observe, instruct, guide, and direct the installing contractor's erection or installation procedures. The equipment manufacturer will be notified with written notification 10 working days prior to the need for such services.

3.3 TRAINING. The manufacturer's representative shall provide training for Owner in proper operation and maintenance of the equipment. Such services shall be included in the contract price.

End of Section

SECTION 15820

DEHUMIDIFICATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of equipment and accessories associated with the dehumidification systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thicknesses. Metal thicknesses and gages as indicated on the Contract Documents are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Temperature Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but not be limited to, the following:

Name of manufacturer.

Type and model.

System flow diagram.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Process fan horsepower.

Reactivation fan horsepower.

Precooling equipment data and capacities.

Post heating equipment data and input/output capacities.

Reactivation heater equipment data and input/output capacities.

Filter velocities.

Dehumidifier performance curves or data and desiccant type.

Process and reactivation entering and leaving air conditions.

Fan performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 5 different rotative speeds.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

<u>Equipment Motors</u>

Name of Manufacturer.

Type and Model.

Horsepower rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

1.4.02 Operation and Maintenance Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. A set of air filters, fan belts, and other belts shall be furnished for each equipment unit.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. The dehumidifiers shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The dehumidifier capacities shall be as indicated in the schedules on the drawings.

Gas fired dehumidifiers shall be suitable for operation with a natural gas or propane inlet pressure range as indicated.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as required.

2.2.03 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as indicated in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 DESICCANT DEHUMIDIFIERS. Honeycomb wheel type desiccant dehumidifers shall be Bry-Air "Model VFB", Cargocaire, or approved equal. Each unit shall be complete with desiccant wheel, process and reactivation air fans, reactivation heaters, volume dampers, motor starters, and a control panel, and shall be completely assembled, wired, and tested at the factory. The dehumidifier shall be capable of removing moisture continuously from the process air stream.

2.5.01 Casing. The unit casings shall be welded aluminum construction with a thickness of at least 0.125 inches (3.2 mm) and shall be properly braced and reinforced with aluminum framework as needed for the operating pressures. The casing shall be provided with the manufacturers standard finish.

Gasketed removable panels or doors shall be furnished to provide access to all internal parts and components. The cabinet shall be constructed to be vapor tight for indoor installation. An observation window shall be provided to permit visual inspection of the bed while the unit is in operation.

The reactivation air and process air sides of the unit shall be divided by a positive sealing arrangement designed for at least 20,000 hours of normal operation. The seals shall be removable and access doors shall be provided for inspections.

2.5.02 Desiccant Wheel. The dehumidifier shall use an automatic, continuous duty, honeycomb style desiccant wheel as required for the adsorption medium. The desiccant material shall be chemically inert, non-corrosive, non-flammable, non-toxic type, and shall contain no asbestos. The wheel shall have a flame spread of 0 and a smoke developed rating not to exceed 10 when tested in accordance with ASTM E84.

The desiccant wheel shall be belt driven and shall have a maximum wheel rotation speed of 10 revolutions per hour.

2.5.03 Reactivation Heater. The type of reactivation heaters shall be electric, direct fired gas, or steam, as indicated in the schedules on the drawings.

2.5.03.01 Electric Type. Electric reactivation air heaters shall consist of an electric heating coil with solid-state modulating control. The controls shall be able to modulate the electric heating coil capacity from 0 to 100 percent. The electric heating coil shall be of open coil zero clearance construction with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames. Bushings shall be ceramic and terminals shall be stainless steel. The electric heating coil control panel shall be completely factory wired to the unit control panel and shall include disconnecting backup and safety contactors, transformers, fusing, disconnect switch, automatic reset thermal cutout, manually reset thermal cutout, and differential pressure airflow switch.

2.5.03.02 Natural Gas Type. Natural gas reactivation air heaters shall consist of a modulating direct fired burner, suitable for use with natural gas. The controls shall be able to modulate the burner firing rate to match the reactivation air requirements. The complete fuel burning assembly shall conform to the requirements of the UL/ETL, FM, or IRI as required. The burner assembly and gas piping arrangement shall include pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valve, electric modulating main gas valve, low and high pressure safety switches, flame rod, spark igniter, ignition transformer, and flame safeguard relay. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment and shall be suitable for an inlet gas pressure range as required.

2.5.03.03 Steam Type. Steam reactivation heaters shall provide heat for the dehumidifier by a steam heating coil utilizing steam. The steam coil shall be a non-freeze type constructed of 5/8 inch (16 mm) OD copper tubes with at least a 0.049 inch (1.2 mm) wall thickness mechanically bonded to aluminum fins. Coils shall be rated for 150 psi (1030 kPa) and tested at 300 psi (2070 kPa) steam working pressure.

Modulating dampers capable of modulating the heating capacity from 0 to 100 percent shall control the reactivation air temperature to match the reactivation air requirements.

2.5.04 Fans. Both process and reactivation air fans shall be factory mounted as part of the unit base. The fans shall be of the single width, single inlet, multiblade, centrifugal type with motor, belt, drives, and guards and shall be arranged to provide counterflow arrangement of the process and reactivation airflows. The fans shall be dynamically balanced and tested after being installed in the factory-assembled fan section. Fans shall be mounted on vibration isolators.

Belt-driven fans shall be complete with V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with smaller than 10 horsepower (7.5 kW) motors and fixed sheaves for 10 horsepower (7.5 kW) and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the appropriate size after the air system balancing, if necessary, to achieve the fan speed required for the specified airflow.

Multiple belts shall be provided in matched sets.

Static pressure values indicated on the schedules are external to the complete unit. The desiccant wheel, filters, and fan housing losses are not included. A filter allowance of 0.35 inch water column (87 Pa) shall be used for filter losses.

A high static fan shall be provided if required to overcome the fan total static pressure.

2.5.05 Filter Section. Dehumidifiers shall be provided with built-in filter racks or filter enclosures fastened directly to the process and reactivation air inlets. Racks or enclosures shall be suitable for housing two inch (50 mm) thick pleated filters. Gasketed access doors shall be provided for removal of filters. Filters shall be removable when the dehumidifier equipment is installed as indicated on the drawings. Air filters shall conform to the requirements of the Air Filters paragraph.

2.5.06 Accessories. Factory mounted volume dampers shall be factory mounted in both the process and reactivation air streams. Dampers shall be of the opposed blade type with positive locking quadrants. A 4 inch (100 mm) U-tube manometer complete with tubes and probes shall be factory installed across the unit for measuring pressure differentials.

2.6 REFRIGERANT DEHUMIDIFIERS. Refrigerant dehumidifiers shall be Desert Aire "LT Series", Dectron, or approved equal as required. Each unit shall be of the packaged, self-contained, closed loop, refrigerant type, completely factory assembled, piped, wired, and tested at the factory. Dehumidifiers shall be of the horizontal type suitable for suspended mounting. The units shall be complete with supply fan, fan motor, compressor, evaporator coil, condenser coil, refrigeration valves, and electrical controls.

2.6.01 Casing. The unit casing shall be constructed of at least 20 gage (0.91 mm) thickness steel and shall be properly braced and reinforced with steel framework as needed for maximum rigidity. The base panel shall be a minimum 14 gage (1.9 mm) thickness steel with welded 1/8 inch (3 mm) steel angle supports on the underside for maximum rigidity. Removable panels shall be provided to allow easy access to internal parts within each section. Access shall be on the side indicated on the drawings. The unit casing and panels shall be provided with the manufacturer's standard enamel finish. The electrical control panel shall be housed in a separate compartment.

The enclosures shall be internally insulated with a flame-attenuated glass fiber insulation bonded with a thermosetting resin. The air stream surface shall be faced with a black coated mat. The insulation shall be securely fastened to the unit enclosure by mechanical means. The insulation shall not exceed a flame spread rating of 25 when tested in accordance with ASTM E84.

2.6.02 Coils. Both the evaporator and condenser coil tubes shall be fabricated from 1/2 inch (13 mm) OD seamless drawn copper. The fins shall be die-formed, plate-type tempered aluminum for easy cleaning and shall be damage resistant.
The tubes shall be hydraulically extruded into the fins to form a permanent metal-to-metal bond. All manifolds, headers, and connecting tubing shall be made with heavy wall seamless copper tubing. Coils shall be leak tested at pressures not less than 400 psig (2760 kPa gauge). Coils shall be designed and tested in accordance with UL and CSA standards. After testing, coils shall be sealed.

Air velocity across evaporator and condenser coils shall not exceed 500 FPM (2.5 m/s). Evaporator coils shall be at least six rows deep with a maximum of ten fins per inch (25 mm). Condenser coils shall be at least four rows deep with a maximum of twelve fins per inch (25 mm).

2.6.03 Compressors. Compressors shall be heavy-duty hermetic reciprocating type with crankcase heater to protect against liquid slugging or scroll type. Compressors shall be equipped with low and high pressure safety switches, and shall be internally protected from overheating. Compressors shall be vibration-isolated internally and externally.

2.6.04 Fans. Dehumidifiers shall have a double-inlet, double-width, centrifugal, forward-curve fan mounted on permanently lubricated sealed or grease lubricated ball bearings, selected for 200,000 hours of average life. Fans shall be dynamically and statically balanced. Fan housings shall be vibration-isolated.

Belt-driven fans shall be complete with V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Sheaves shall be of the adjustable type and shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the appropriate size after the air system balancing, if necessary, to achieve the fan speed required for the specified airflow.

Multiple belts shall be provided in matched sets.

Static pressure values indicated on the schedules are external to the complete unit. Internal coil(s), filter and fan housing losses are not included. A filter allowance of 0.35 inch water column (87 Pa) shall be used for filter losses.

A high static fan shall be provided, if required, to overcome the fan total static pressure.

2.6.05 Filter Section. Dehumidifiers shall be provided with built-in filter racks or filter enclosures fastened directly to the process air inlets. Racks or enclosures shall be suitable for housing filters one or two inches (25 or 50 mm) thick. Gasketed access doors shall be provided for removal of filters. Filters shall be removable when the dehumidifier equipment is installed as indicated on the drawings. Air filters shall conform to the requirements of the Air Filters paragraph.

2.6.06 Accessories. Dehumidifiers shall be furnished with a sloped condensate drain pan constructed of stainless steel and positioned under the dehumidifier coil. The drain pan shall extend sufficiently past the evaporator coil to capture and collect any condensate carryover that may occur when the unit is operating. It shall be formed of 20 gage (0.91 mm) thickness stainless steel, silver-solder welded, and attached securely to the evaporator end plates. The drain pan shall be pitched to completely drain and fitted with a 1 inch (25 mm) NPT non-corrosive plastic drain connection.

Refrigerant type dehumidifiers shall include the compressor and condenser fan motor starters; start and run capacitors; high and low pressure control with manual reset of the high pressure cut out, and automatic reset of low pressure cut out; anti-cycling timer to protect against compressor cycling, and indicating lights. Indicating lights shall be provided to indicate system, fan, and compressor operation.

Refrigerant type dehumidifiers shall also include an electrically controlled damper assembly within the unit enclosure to maintain optimum coil temperature under varying load conditions. The unit shall be equipped with a low ambient valve to control discharge pressure regardless of ambient condensing temperatures. A hot gas bypass valve to prevent the coil from freezing shall be provided. A diverting valve shall be provided to control refrigerant flow through the condenser coil or water-cooled condenser depending on space temperature requirements.

2.7 AIR FILTERS. Filters shall be American Air Filter "AM-AIR 300X", Farr "30/30", or approved equal. Filters shall be disposable type, with 1 or 2 inch (25 or 50 mm) thick, high-loft blend of cotton and synthetic fiber pleated media. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame.

Unless otherwise specified, all filters shall have an average efficiency of 25 to 30 percent based on the ASHRAE 52.1-92 test method. The filters shall have a maximum initial resistance of 0.13 inch water column at 300 feet per minute (30 Pa at 1.5 m/s).

2.8 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.9 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2.9.01 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor unless otherwise indicated.

2.9.02 Safety Guards. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized.

2.9.03 Electric Motors. Motors furnished with equipment shall meet the following requirements.

> A manufacturer's standard motor may be supplied on packaged equipment in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall

be furnished if offered by the manufacturer as a standard option.

Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

Designed for full voltage starting.

Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

Bearings shall be either oil or grease lubricated.

Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feeding and chemical handling locations.

4. Equipment operating in wet or dust-laden locations.

Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
   115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
   460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase.
Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

2.10 CONTROLS. Dehumidifiers shall be provided with an electrical control panel. The control panels shall be easily accessible after dehumidifier installation. Control panels shall be factory prewired with protective fuses, contactors, motor starters, control transformer, overload protection, pilot lights, relays, and all necessary components to insure continuous automatic operation. The control panels shall be of adequate size to house all electrical controls and devices necessary to provide control as described in the Sequence of Operation. Controls shall be suitable for 120 volts, 60 Hz, single phase power supply.

Humidistats for on-off operation of the unit shall be furnished and installed where indicated on the drawings

A condensation controller for on-off operation of the unit shall be furnished and installed. The controller shall consist of a control power module and a sensor module mounted where indicated on the drawings. The control power module shall contain the power supply, differential setpoint adjustment switch, signal indicating lights, and control relay to start and stop the dehumidifier. The sensor module shall continuously monitor the surface humidity level and the control power module shall compare it to the selected differential dew point setting and control the unit accordingly.

2.11 SHOP TESTING. The equipment shall be factory tested and the test results shall be delivered to Engineer. Equipment shall not be shipped until Engineer has received the test results and advised Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

2.12 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01 Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3.2.02 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. The dehumidification systems shall be installed where indicated on the drawings. Flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. The flexible connections shall comply with the requirements of Master Specification Section 15880, Air Distribution Systems.

Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, preliminary field and field system operation tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.4.03 Operator Instruction and Training. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided as required. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as necessary for compliance.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15845

REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 SCOPE. This Section covers the furnishing and installation of stainless steel supply registers and exhaust grilles, and appurtenances associated with heating and ventilation systems. It shall include the following duct mounted air outlets and inlets:

Supply Registers

Exhaust Grilles

1.2 SUBMITTALS.

1.2.01 Product Data. For each model indicated, include the following:

Data Sheet: Indicate construction, finish, and mounting details for each type of air outlet, inlet, and accessory indicated.

Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet indicated.

Schedule of registers and grilles indicating drawing designation, room location, quantity, model number, size, and accessories.

Assembly Drawing: Indicate materials and methods of assembly of components for each type of air outlet and inlet indicated.

1.3 QUALITY ASSURANCE. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.1 MANUFACTURERS. In other Part 2 articles where subparagraphs titles below introduce lists, the following requirements apply for product selection:

Products: Subject to compliance with requirements, provide one of the products specified.

2.2 REGISTERS.

2.2.01 Supply Register. Stainless Steel, 3/4” spacing, Double-Deflection

Acceptable Manufacturers:

Titus; Model 300 RL-SS.

Krueger

Or approved equal

Material: Roll-formed, Type 304 Stainless Steel

Face Blade Arrangement: Adjustable parallel to short dimension

Rear Blade Arrangement: None.

Frame: 1-1/4 inches

Mounting: On Ductwork.

Damper Type: Adjustable opposed-blade assembly, Type 304 Stainless Steel.

2.3 GRILLES.

2.3.01 Exhaust Grille. Stainless Steel, 3/4” spacing, 45° fixed deflection

Acceptable Manufacturers:

Titus; 350 RL-SS

Krueger

Or approved equal

Material: Roll-formed, Type 304 Stainless Steel

Face Blade Arrangement: 45° Fixed parallel to long dimension

Frame: 1-1/4 inches

Mounting: On Ductwork.

2.4 SOURCE QUALITY CONTROL.

2.4.01 Testing. Test performance of registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION. Ductwork-Installed outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable.

Install registers, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

End of Section

SECTION 15855

AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SCOPE. Furnish and install all indoor make-up air handling units with filters as shown on the Drawings, scheduled and as specified herein.

1.2 SCHEDULES. All units shall be of the type, capacity and arrangement as listed on the schedules. Units shall consist of the components listed in the schedule and those components obviously required for the type of unit. Unit shall be capable of being installed together in sections in the final location where shown on the drawing or as one entire unit. The order of component assembly will be as called for on the schedule. Particular attention must be paid to the remarks and notes in these schedules.

1.3 SUBMITTALS. Submit, in accordance with Sections 01160 and 15501, the following:

Unit data sheets; to include catalog data, a description of the proposed unit, size, type, arrangement, and materials of construction.

For belt drive equipment, provide drive data indicating sheave sizes, belt size, number and length.

Each submittal shall include pertinent equipment dimensional data, heating and cooling coil operating data. Submit, in accordance with Sections 01160 and 15501, all data and the fan schedules. The submittal shall include fan data sheets with a description of the proposed fan, fan size, type, arrangement, materials of construction, weight, motor horsepower, motor type, power supply, and frame size. Provide catalog data and selections for vibration isolators, include materials of construction. For belt drive equipment; provide drive data indicating the sheave sizes, belts size, number and length. Each submittal shall include pertinent equipment dimensional data, fan performance (operating data information, and a performance curve showing the fan operating point and range. Minimum curve size shall be 8-in by 6-in. Faxed copies of curves are not acceptable. A list of accessories to be furnished shall be included on each submittal. Copies of operating and maintenance manuals shall be submitted.

Significant dimensional differences between the specified equipment and the proposed equipment shall be noted on the equipment submittal. The Contractor shall provide data to show the dimensionally different equipment will fit within the space and still provide suitable clearance. Where corrosion resistance is required, provide conformation of material suitability for the specified service.

For condensing sections provide information on number and type of compressors, type of refrigerant and refrigerant charge, and controls provided and operating weight. Provide electrical data for power and controls. For condensing coils, provide air entering and leaving conditions, air pressure drop, size, type, arrangement, and materials of construction.

List of accessories to be furnished shall be included on each submittal. Provide a recommended list of spare parts.
Significant dimensional differences between the specified equipment versus the proposed equipment shall be noted on the equipment submitted.

For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

All submittals shall contain a statement that Section 15501, and all other Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

Submit to the Engineer as provided in Section 01730, Operating and Maintenance Manuals. The following information shall be considered a minimum. Where applicable, provide information required for specific pieces of equipment.

Personnel familiar with the operation and maintenance of the specific information shall prepare manuals.

Equipment shall be identified with the Engineers Equipment Numbers and Identification as shown in the Schedules and on the Drawings.

Provide information in three ring binders. All sheets shall have reinforced punches. Tabbed dividers shall separate all sections. Drawings will be bound in the manual, or contained in envelopes bound into the manual.

Contents - Each volume shall contain the following minimum contents:

Installation including instructions for unpacking, installing, aligning, checking and testing. Foundation data, allowable piping loads, and electrical design shall be included.

Operating Instructions to provide pre-operational checks, start up and shut down, and description of all control modes. Include emergency procedures for all fault conditions and actions to be taken for all alarms. Procedures for long term storage shall be included.

Maintenance shall include preventive, and corrective. Schedules for test of other functions are to be included. Provide a list of tools required to service the equipment. Trouble shooting instructions to include a trouble-shooting guide shall be included.

Shop Drawing Data to include performance curves, data sheets, flow diagrams, wiring diagrams, and descriptive drawings.

In general, corrections or comments or lack there of, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4 REFERENCE STANDARDS. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

ASHRAE 52 - Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

Air Movement and Control Association (AMCA) National Fire Protection Association (NFPA)
NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems

NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

American Society for Testing and Materials (ASTM)

ASTM C581 - Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass- Fiber- Reinforced Structures Intended for Liquid Service.

ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Materials).

Air-conditioning and Refrigeration Institute (ARI)

American Society of Mechanical Engineers (ASME)

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

Association of Home Appliance Manufacturers (AHAM)

Factory Mutual (FM)

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE. All equipment of a given type included in this section shall be furnished by or through a single manufacturer or as specified on the schedules. Inspection by the Engineer's representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements. An authorized representative of the manufacturer shall perform the initial startup of the equipment. The Owner and Engineer shall witness startup. The use of local sales representatives to perform this work is not acceptable, unless the manufacturer provides documented evidence that the sales representative has been specifically trained for this work. All rotating parts of equipment shall be dynamically balanced at the factory.

1.6 DELIVERY, STORAGE AND HANDLING. Shipping, handling and storage are detailed in the Master Specification Section 01180.

Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

All equipment shipped that is exposed such as on a flatbed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

Instructions for the servicing and startup of equipment in long term prolonged storage shall accompany each item.

All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.7 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts and shall meet the requirements of Sections 01180.

Furnish all special tools required for normal operation and proper servicing of the equipment. Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:

One complete set of drive belts for each piece of belt driven equipment

One complete shaft seal for all fans with shaft seals. Three full sets of air filters if not otherwise specified.

1.8 WARRANTY. In addition to the General Warranty, the equipment manufacturer shall warrant against parts and labor and any defect in material, construction, or performance of the Make Up Air Units and its components for a period of five (5) years from the date of acceptance for the Equipment, without any cost to the owner.

1.8.01 MAINTENANCE SERVICE. Concurrent with Parts and Labor Warranty, Manufacturer shall provide Five (5) year Full Maintenance program. Maintenance program shall include monthly service visits on each unit subject to the following:

Filter changes

Digital Performance Log

Check and/or replacement of belts

Check, Lubrication and/or replacement of fan bearing assemblies

Check and/or adjustment/replacement of electrical or control components

Check and/or adjustment/replacement of damper and operators

Check and/or adjustment/replacement of cabinetry seals, latches, panels etc

Check and/or cleaning of interior unit and coil surfaces

The above at a minimum shall appear on a Monthly Maintenance Sheet for each unit. Verification of maintenance via this sheet shall bear Witness signature of DWSD representative and turned in monthly in hard copy and/or digital copy in quantities up to Five (5) sets as determined by the DWSD. Sheet and format to be approved by DWSD prior to commencement of Five (5) Year Program.

1.8.02 WARRANTY SUBMITTAL. Submit a Written warranty signed by manufacturer agreeing to repair, restore, or replace defective work and maintain as specified in this section, within the specified warranty period without any cost to the owner.

PART 2 - PRODUCTS

2.1 MAKE-UP AIR UNITS. Acceptable manufacturers shall be Rush Air or approved equal.

2.2 DESIGN AND CONSTRUCTION. In general, units shall be factory assembled, packaged industrial type with fan, heating section, filters, motorized intake dampers, access sections with hinged access doors, motor, starters, motor base, gas train, gas pressure reducing valve, controls, drive, drive guard and vibration isolators. Rooftop units shall be completely weather proof. All units as shown and specified shall be furnished by the same manufacturer. Units shall be designed to provide an integrated assembly and factory tested when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit. The equipment dimensions shall be coordinated to fit in the space allocated in the Mechanical Room. Support brackets or rails are to be provided with the floor- mounted unit. Units shall have all rotating components internally isolated from the main unit with vibration isolators and floor mounting rails.

2.2.01 Casings. The unit casing shall be 2” double wall constructed of 20 ga, 304 Stainless Steel for both inner and outer liner. Unit floor shall be double wall 14 ga, 304 Stainless Steel. In addition, Unit frame, unit coil frames and all structural components shall be constructed of 304 Stainless Steel. Removable panels and access doors shall be 2” double wall constructed utilizing 20ga 304 Stainless Steel for both inner and outer skins. Insulation: Insulation shall be 2” thick closed cell foam. All sections including, but not limited to, filter, spacers, access sections, fan cabinet, shall be insulated. Insulation shall be 25.4 mm (1-in) verify all English units dims provided mat faced or neoprene coated fiberglass liner, 24 kg/M3 (1-1/2 lb/ft3) minimum density, installed with stick clips and adhesives to prevent erosion of the insulation.

2.2.02 Fan Section. Fans shall be centrifugal cabinet fans with belt drives. Extended external lubrication fittings shall be provided. Drives shall be adjustable V-belt type, with motor mounted on an adjustable slide base.

Backward curved wheels shall be airfoil types.

All fans shall be statically and dynamically balanced before shipment. All fans shall be AMCA rated for sound and air performance.
Motor shall be energy efficient TEFC, with internal load protection.

Factory wired controls shall be provided in the unit control panel. Panel shall include all safety controls and interlocks, control devices and terminal strip for remote wired devices. Control type shall be as specified on the schedules. Control voltage shall not exceed 120 Volt.

Makeup AHU’s shall utilize SWSI plenum style fans for supply air. Fans shall be constructed of 304 stainless steel. Fans performance shall be as scheduled. Fan Bearings shall be rated for L10 at 200000. Fan housing shall be vibration isolated.

2.2.03 Filters. Filter Box shall have tracks for the specified filter types, to allow filter replacement from either side. Sealing material shall be provided at tracks and ends to prevent air by-passing the filters.

Disposable Filters shall be framed filters, 50.8 mm (2-in) thickness as scheduled. Filter pressure drop for clean filters at 91 M\min (300 fpm) face velocity shall be 0.15-in wg for 50.8 mm (2-in) thick filters. Filter shall have 30 to 35 percent efficiency on ASHRAE Test Standard 52. Manufacturers and type shall be American Air Filter Co., AmAir 300X; Farr Co., 30/30 Disposable; Cambridge, Aeroplate or equal.

A total of three complete sets of filter media shall be provided for each unit.

For all types of filters, each filter section shall be provided with a magnehelic type gauge to indicate static pressure across the filter. Where more than one filter is used in series, each filter shall be provided with its own gauge. Where a control panel is provided gauges shall be mounted in the control panel.
2.2.04 Unit Control Panel. Remote panels shall include all stand alone DDC controls, and all safety controls and interlocks, heavy duty fused visible break, disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other Sections and on the Drawings. Control voltage shall not exceed 120 Volts. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door. Provide hardware and software as required to monitor with
remote building central DDC management system. Remote LCD display shall show lights for dirty filter, alarm, fan on/off, air temperature heat on/off etc.

All air handling control devices shall be compatible with control devices supplied under Section 15950 by the successful Temperature Control Contractor Division 15. The Make-up Air Unit Manufacturer shall coordinate with the Control and Mechanical contractors.

For self-contained package units, split systems and fuel burning units, factory wired control panel shall be furnished and mounted on the unit. Panels shall include all controls required in other sections, and all safety controls and interlocks, heavy duty fused visible break, disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other Sections and on the Drawings. Control voltage shall not exceed 120V. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door.

Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings:

NEMA 12 for indoor locations.

2.2.05 Accessories. Dampers shall be opposed blade type with blades mounted on 1/2-in minimum steel rods. Dampers shall be provided with low friction bushings and edge gaskets to reduce air leakage. Blades shall be sectionalized to limit unsupported blade length and warping at full system fan static pressures. Maximum damper blade width shall not exceed 6-in.

Provide top discharge section for air discharge.

Access sections shall have hinged doors for servicing.

Provide smoke detector, low and high temperature stats with additional contacts and accessories.
Provide airflow sensing switch to prove airflow and set visual and audible alarm in case of failure.

2.3 TESTING. Factory performance testing shall be provided using the governing standards of ARI, ASHRAE and SMACNA. These tests will be performed with the option of witnessing by the owner or owner's representative. Complete test procedure must be submitted for approval prior to testing. Approved testing procedures may then be scheduled. Run test will include but not limited to Air flow. Energy consumption, largest panel deflection test, per SMACNA and component verification (match components to submittal data).

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment shall be installed in accordance with manufacturer's recommendation. Provide piping and ductwork connections in accordance with the requirements of the other related Sections. Wire and install any equipment shipped loose for field installation.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

When units are shipped disassembled, field connect all sections including wiring together as shown on the Drawings to form single air handling unit. Seal all joints with gaskets and/or sealants.

Do not operate equipment without filters. Do not run equipment with dirty filter pressure drop more than twice clean filter pressure drop. A total of three complete sets of filters shall be provided. The first set is to be installed for start-up, test and balancing. The second set shall be installed after final cleanup and acceptance by the Owner. The third set shall be turned over to the Owner as a spare.

The Contractor shall start up each piece of equipment and system and shall make all adjustments so that the system is placed in proper operating condition.

Install unit level and plumb, maintaining manufacturer's recommended clearances and tolerances.

Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 7 Section "Joint Sealants."

Install wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

Provide necessary supports to accommodate weight of unit. Supports shall be epoxy coated to withstand corrosion. Provide vibration isolation fittings.

3.2 CONNECTIONS. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls. Ground equipment according to Division 16 Section "Grounding and Bonding."

End of Section

SECTION 15880

AIR DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of air distribution equipment, coils, fans, ductwork, duct mounted devices, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment and materials furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable

municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with UL safety requirements. Fans shall be UL listed.

1.2.04 Power Supply. Power supply to equipment with motors shall be as indicated in schedules on the drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

1.2.05 Metal Thickness. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All equipment, piping, valves, ductwork, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Major Equipment	3/4 (19)
Minor Equipment	1/2 (13)

Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plate. Nameplates and tags shall be at least 12 gage (2.66 mm) thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm). Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners.

1.3.02 Equipment Plates. Mechanical equipment shall be identified with engraved or stamped equipment plates securely affixed to the equipment in an accessible and visible location. Equipment plates shall be in addition to the number plates specified in the preceding paragraph. Equipment plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data. Equipment plates listing the distributing agent only will not be acceptable.

1.3.03 Piping. Piping identification shall be as specified in Master Specification Section 09900, Painting.

1.3.04 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.3.05 Ductwork. As required, ductwork shall be identified with nameplates as specified herein, or stenciled painting as specified in Master Specification Section 09900, Painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section

01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Central Station Air Handling Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Coil capacities and velocities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower (kW), static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least five different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

Makeup Air Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Burner or heating coil capacities.

Filter velocities.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least five different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

<u>Fans</u>

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Overall dimensions and required clearances.

Net weight and load distribution.

Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute (m^3/s) as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least three different rotative speeds on a single chart.

Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10^{-12} watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

Schematic control wiring diagrams showing multiline wiring for the unit and all interconnecting devices. Wiring diagrams shall be detailed to the degree required for field construction, with all terminals identified.

Equipment

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Manufacturer's performance data.

Overall dimensions and required clearances.

Net weight and load distribution.

Wiring diagrams.

Sheet Metal Fabrication Drawings

Duct layout drawings indicating shop fabricated sections and dimensions.

Pressure and seal classifications.

Access panel and door construction, sizes, and locations.

Duct sealant, adhesive, gasket, and tape information.

Coatings.

Ductwork materials.

Coatings

Name of manufacturer.

Coating type.

Chemical resistance data.

Temperature range data.

Surface preparation and application data.

Film thickness per coat.

Drying and curing time.

Color.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower (kW) rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

Adjustable Frequency Drive

Type and model.

Name of manufacturer.

Operating speed range, rpm.

Rated bhp (kW) at maximum speed.

Efficiency at maximum speed, percent.

Maximum heat output, BTUH (kW).

Speed at maximum heat output, rpm.

Dimensions and net weight of complete panel.

Catalog and data sheets on all components.

Electrical schematics and wiring diagrams.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

A listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4.03 Samples. Samples of protective coatings for equipment as required shall be submitted to Engineer for approval. The samples shall be at least 3 inches by 3 inches (75 mm by 75 mm) in size, and shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.5 QUALITY ASSURANCE.

Central station air handling units shall be certified in accordance with ARI 430.

Central station air handling unit coil capacities, pressure drops, and selection procedures shall be certified in accordance with ARI 410.

Electric heating coils shall comply with the National Electrical Code.

Direct fired makeup air units shall be independently certified to meet ANSI Z83.4.

Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the drawings, and shall be UL listed.

1.5.01 Welding Qualifications. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

1.5.02 Manufacturer's Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools.

1.7 EXTRA MATERIALS. One set of matched belts per unit and two sets of air filters per unit shall be furnished for the equipment.

Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

1.8 FRP DUCTWORK REGULATORY REQUIREMENTS. Comply with NFPA No. 255 for flame spread rating of 25 or less. Comply with NBS-15p69 and ASTM D4097.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. Equipment and coil capacities shall be as indicated on the schedules.

Gas fired equipment shall be suitable for operation with a natural gas or propane inlet pressure range as indicated.

Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

2.2.01 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer’s layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.2.02 Elevation. Equipment shall be designed to operate at the elevation as indicated.

2.3 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION.

2.4.01 Welding. All welds shall be continuous (seal type) on submerged or partially submerged components.

2.4.02 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.03 Edge Grinding. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

2.4.04 Surface Preparation. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4.05 Shop Coating. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for topcoating in the field with a universal primer and aliphatic polyurethane system. Heated surfaces shall be painted with heat resistant paint.

Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer. Field painting shall be as indicated in Master Specification Section 09900, Painting.

Machined, polished and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the manufacturer.

2.4.06 Equipment Bases. Unless otherwise indicated or specified, all floor and grade mounted equipment will be installed on concrete bases at least 6 inches (150 mm) high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

2.4.07 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 CENTRAL STATION AIR HANDLING UNITS. Central station air handling units, denoted by the symbol "AHU" and an identifying number, shall be manufactured by McQuay, Trane, York, or approved equal. Each central station air handling unit shall be complete with all sections and components indicated on the drawings.

2.5.01 Casing. Central station air handling units shall be factory built and tested draw-through units. The units shall be constructed of properly braced and reinforced steel framework with G90 galvanized steel panels as needed for the operating pressures. Gasketed removable panels or doors shall be furnished to provide access to all internal parts and components. The unit shall be constructed such that removal of side panels will not affect the structural integrity of the unit.

The casing shall be of sectional construction, consisting of a fan section, a cooling coil section with a sloped drain pan, a heating coil section, a face and bypass damper section, a filter section, blender section, and an access/spacer section as indicated on the drawings. The cabinets and casing shall be provided with the manufacturer's standard galvanized finish. Where indicated in the schedules on the drawings, units shall be double wall construction. When a unit is indicated to have double wall construction, all sections shall be constructed with internal liners. Liners shall be constructed of at least 20 gage (0.91 mm) thickness galvanized steel.

Sloped drain pans shall extend under the entire cooling coil section and sufficiently past the coil to capture and collect any condensate carryover when the unit is operating within the specified conditions. The unit design shall not require a drain pan in any downstream section to contain coil condensate. The drain pan shall be accessible for inspection and cleaning. The drain pan shall be constructed of stainless steel cross broken and pitched (double sloped) to the drain connection. The drain pans shall be completely insulated.

The interior of the fan section, coil section, and accessory sections shall be insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density, cleanable blanket type fiberglass insulation securely fastened to the panels. Insulation shall meet the requirements of the NFPA.

2.5.02 Fan Section. The fans shall be of the double width, double inlet, multiblade type. Wheel type shall be as indicated in the schedules on the drawings. Fans shall be dynamically balanced and tested after being installed in the factory-assembled fan section. The maximum fan speed shall not exceed 80 percent of the first critical speed. The units shall have externally mounted grease lubricated bearings or lubrication fittings extended to the exterior fan casing, with copper tubing and grease fittings rigidly attached to the casing. The fan bearings shall be self-aligning, grease lubricated ball type with an average life (L50) of at least 200,000 hours.

Static pressure values indicated in the schedules on the drawings are external to the complete unit. Internal coil(s), face and bypass damper, filter, and fan housing losses are not included. A filter allowance of 0.35 inches water column (87 Pa) shall be used for 2 inch (50 mm) pleated filter losses and 0.80 inches water column (200 Pa) shall be used for extended surface air filter losses.

2-5.03 Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors and controls shall be as specified in the Electrical paragraph.

Central station air handling units with smaller than 10 horsepower (7.5 kW) motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower (7.5 kW) and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets. Belt drives shall be designed for 1.5 times the fan brake horsepower.

Where indicated in the schedules on the drawings to be explosionproof, central station air handling units shall be suitable for installation in an NEC Class I, Division 2, Group D area.

2.5.04 Coil Section. The cooling and heating coils required by the central station air handling units shall be manufactured by the same manufacturer as the air handling units. Cooling and heating coils shall conform to the requirements of the Coils paragraph. Coil headers and return bends shall be completely enclosed by the unit casing. Coil connections, vents, and drains shall extend outside the unit casing and shall be clearly labeled.

Central station air handling units with hydronic cooling coils shall be selected to limit cooling coil velocities to 550 feet per minute (2.8 m/s) at the design airflow unless otherwise indicated in the schedules on the drawings. Central station air handling units with hydronic heating coils shall be selected to limit the heating coil velocities to 750 feet per minute (3.8 m/s) at the design airflow unless otherwise indicated in the schedules on the drawings.

2.5.05 Filter Section. Filter sections for central station air handling units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 300 feet per minute (1.5 m/s) for pleated air filters or 500 feet per minute (2.5 m/s) for extended surface air filters at design conditions, unless otherwise indicated in the schedules on the drawings. Gasketed access doors shall be provided for removal of filters from either side of the section. The filter thickness shall be as indicated in the schedules on the drawings and shall conform to the Air Filters paragraph.

2.5.06 Face and Bypass Damper Section. Face and bypass damper sections for central station air handling units shall be of the internal or external type as indicated in the schedules on the drawings. The dampers shall be opposed blade, low leakage type arranged to match the heating coil face area with top bypass. The damper shall have a maximum leakage rate of 10 cubic feet per minute per square foot at 4 inches water column (0.05 m^3/s per m^2).

2.5.07 Air Blender Section. Air blender sections for central station air handling units shall be factory installed within the unit. Air blenders shall be fixed devices with suitable clearances up and down stream of the blender for proper performance and uniform airflow through downstream components. The air blender shall be fabricated of 0.080 inch (2 mm) aluminum designed to mix the two airstreams to within ±6°F (3°C) of the theoretical mixed air temperature.

2.5.08 Accessories. Where indicated in the schedules on the drawings as variable volume with inlet vanes, central station air handling units shall be furnished with integral variable inlet vanes complete with a control ring, crank arms, a connecting shaft, and all interconnecting linkages required to provide a complete, properly operating unit.

Central station air handling units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage (1.9 mm) thick zinc-coated steel with a nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply and return air opening as indicated on the drawings. The curb shall be a minimum of 16 inches (400 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.6 COILS. Hydronic coils shall be of the drainable type with plugged vent and drain tappings.

Where indicated in the schedules on the drawings, coils shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.6.01 Hydronic Heating Coils. Heating coils, denoted by the symbol "HC" and an identifying number, shall be McQuay, Trane "Type W", York, or approved equal (installed in air handling equipment) or McQuay, Trane "Type ST", York, or approved equal (installed in ductwork).

Hydronic heating coils shall be extended surface type, arranged in a rectangle to fit the space available. The coils shall be designed for a working pressure of 200 psig (1380 kPa gauge) and shall have been hydrostatically tested and proved watertight at 200 psig (1380 kPa gauge). Coil casings shall be of galvanized or stainless steel and shall be rigidly braced. Coil headers shall be constructed of cast iron or a nonferrous material. Coil tubes shall be at least 0.024 inch (0.61 mm) thick, 5/8 inch

(16 mm) OD seamless copper with at least 0.006 inch (0.15 mm) thick aluminum fins mechanically bonded to the tubes. Seals shall be provided at top, bottom, and intermediate channels to minimize air bypassing the coil surface. Inlet and outlet connections shall be on the same end of the coils. Coils shall be removable from either side of the air handling unit.

The face velocity of a heating coil installed in ductwork shall not exceed 900 feet per minute (4.6 m/s) at maximum airflow.

2.6.02 Direct Expansion Cooling Coils. Direct expansion cooling coils, denoted by the symbol "CC" and an identifying number, shall be manufactured by McQuay, Trane, York, or approved equal.

Direct expansion cooling coils shall be multirow, 1/2 inch (13 mm) or 5/8 inch (16 mm) OD seamless copper tubes of 0.025 inch (0.64 mm) nominal wall thickness mechanically bonded to aluminum fins. Direct expansion cooling coils used in systems with multiple steps or circuits shall have interlaced circuitry. Refrigerant shall be distributed equally to multiple circuits by a pressure type distribution header with minimum pressure drop through the header and tubing. Coils shall be matched with the condensing unit or heat pump and shall be tested at 250 psig (1725 kPa gauge) prior to dehydration. Coils shall be purged and sealed with inert gas prior to shipment.

2.6.03 Hydronic Cooling Coils. Cooling coils, denoted by the symbol "CC" and an identifying number, shall be McQuay, Trane "Type W", York, or approved equal. Hydronic cooling coils shall be extended surface type, arranged in a rectangle to fit the space available. The coils shall be designed for a working pressure of 200 psig (1380 kPa gauge) and shall have been hydrostatically tested and proved watertight at a working pressure of 200 psig (1380 kPa gauge). Coil casings shall be constructed of galvanized steel and shall be rigidly braced. Coil headers shall be constructed of cast iron or nonferrous material. Coil tubes shall be at least 0.024 inch (0.61 mm) thick, 5/8 inch (16 mm) OD seamless copper with at least 0.006 inch (0.15 mm) thick aluminum fins mechanically bonded to the tubes. Cooling coils shall be rated for use with a fouling factor of 0.0005.

2.6.04 Electric Heating Coils. Electric heating coils, denoted by the symbol "HC" and an identifying number, shall be manufactured by Indeeco, Brasch, or approved equal. Electric heating coils shall be of open coil or finned tube zero clearance construction, as required, with 80 percent nickel and 20 percent chromium resistance elements. Heaters shall have galvanized or aluminized welded steel frames with flanges suitable for fastening directly to the fan or coil and filter sections.

Bushings for open coils shall be ceramic and terminals shall be stainless steel. Elements for finned tubular coils shall be centered in steel tubes filled with compacted magnesium oxide and copper plated fins brazed to the tube. The assembly shall be finished with high temperature aluminum coating.

A remote electric heating coil control panel shall be furnished and installed where indicated on the drawings. The electric heating coil control panel shall be completely factory wired and shall include disconnecting backup and safety contactors, transformers, fusing, and a disconnect switch. The heating coil terminal box shall include an automatic reset thermal cutout, a manually reset thermal cutout, a differential pressure airflow switch, and a pilot switch. The control panel shall be furnished with double doors.

The contactors shall be rated for 600 volt, 3 pole, UL listed, and shall have a life expectancy for 100,000 operations. The control transformer shall be built-in, industrial dry type, 480/120 volt sized to carry the full control system load. Primary and secondary windings shall be fused, and secondary windings shall have one lead grounded.

The heater shall be furnished with a silicone controlled rectifier (SCR) control unit mounted in the remote electric heating coil control panel. The SCR control unit shall be suitable for operation at temperatures of 32° to 132°F (0° to 55°C) and shall be solid-state, proportioning type, designed to modulate the heater output from 0 to 100 percent. The heater shall be controlled by a thermostat as indicated on the drawings. The SCR controller shall be compatible with the signal from the thermostat.

The electric heating coil output shall be as specified at 460 volts, 60 Hz, 3 phase. The heater elements shall be suitable for operation on 480 volt, 60 Hz, 3 phase power.

2.7 <u>MAKEUP AIR UNITS</u>. Makeup air units, denoted by the symbol "MAU" and an identifying number, shall be Hastings "SBD", Hartzell "GMC", Engineered Air "Series HE", or approved equal for direct fired units and Hastings "Counterflo", Engineered Air "Series DJ", or approved equal for indirect fired units as indicated in the schedules on the drawings. The makeup air units shall be constant volume, gas-fired type, and shall be completely assembled, wired, and flame tested at the factory.

Where indicated in the schedules on the drawings, makeup air units shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.7.01 <u>Construction</u>. The casing of the makeup air unit shall be of sectionalized construction consisting of a fan section, a gas-fired burner section, a filter section, and, when located outdoors, an inlet hood with motorized control damper. The unit housing shall be constructed of heavy gage galvanized paint grip carbon steel or aluminized steel, braced and reinforced with steel framework as needed for the operating pressures. The cabinet and casing shall be provided with the manufacturer's standard enamel finish. Gasketed and hinged doors shall be furnished to provide access to all internal components. An observation port shall be provided on the burner section for viewing the pilot and main flames.

The burner section shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density foil-faced fiberglass blanket insulation securely fastened to the panels. The fan and accessory sections shall be internally insulated with 1 inch (25 mm) thick, 1-1/2 pound per cubic foot (24 kg/m^3) density mat-faced cleanable fiberglass blanket insulation securely fastened to the panels. Where the insulation is not installed below the floor, the insulation shall be protected by a metal liner. The insulation shall meet the requirements of NFPA.

Makeup air units installed outdoors shall be of weatherproof construction, with roof panels pitched for drainage. The roof panels shall be constructed with triple-break seams which overlap the side panels on all sides. All exterior joints shall be bolted or screwed with a gasket, or shall be welded, and shall be sealed weather tight.

Makeup air units installed outdoors shall have a stormproof weather hood with birdscreen sized for 100 percent outside air shall be mounted on the unit inlet. The hood shall include a two-positioned motorized control damper which opens when the unit is energized and closes when it is de-energized.

2.7.02 Fan Section. The makeup air units shall be equipped with centrifugal fans with forward-curved blades which shall be dynamically balanced and tested after being installed in the factory assembled fan section. Bearings shall be heavy-duty, self-aligning, grease lubricated type for units with motors greater than 15 horsepower (11.2 kW) and permanently lubricated or grease lubricated for units with 15 horsepower (11.2 kW) motors and smaller. Units with regreasable bearings shall have externally mounted, grease lubricated bearings or lubrication fittings extended to the exterior fan casing with aluminum or copper tubing and grease fittings rigidly attached to the casing.

Static pressure values indicated in the schedules are external to the complete unit. Internal burner or heat exchanger, filter, and fan housing losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for filter losses.

2.7.03 Motor and Drive. Units located outdoors shall have internally mounted motors. Units located indoors shall have fan motors mounted either in or on the fan housing. Internally mounted motors shall be installed on a steel base mounted on internal vibration isolators and coated with the manufacturer's standard protective coating. Where unit is installed in a seismic area, seismic restraints shall be provided. Externally mounted motors shall be installed on integral casing framework on the exterior of the casing. Units with externally mounted motors shall be furnished with vibration isolator units as indicated in the schedules on the drawings. External belts and drive assemblies shall be protected by a belt guard with tachometer opening.

Fan drive motors and controls shall be as specified in the Electrical paragraph.

Makeup air units with smaller than 10 horsepower (7.5 kW) motors shall have V-belt driven fans with adjustable pitch sheaves and units with 10 horsepower (7.5 kW) and larger motors shall have fans with fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required fan speed for the specified airflow. Multiple belts shall be provided in matched sets.

2.7.04 <u>Heating Section</u>. The complete fuel burning assembly shall conform to the requirements of UL/ETL, FM, or IRI as required. The burner assembly and gas piping arrangement shall include, but not be limited to, pilot and main burner gas manual shutoff valves, pilot and main gas regulators, pilot and main gas safety shutoff valves, manual pilot adjustment valves, and electric modulating main gas valves. The burner assembly and gas manifold shall be completely piped and tested at the factory prior to shipment.

The unit shall be suitable for use with the gas pressure range as required.

2.7.04.01 <u>Direct Fired</u>. Burners shall be in-line type, suitable for use with natural or propane gas, as required, and shall be complete with stainless steel firing plates, cast iron gas feed, and stainless steel side plates for flame rods and ignition spark rods mounted in ceramic isolated bushings. The profile plates shall be adjustable and shall be sized to maintain the required velocity across the burner. The burners shall be capable of modulating turndown of 20 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff.

2.7.04.02 <u>Indirect Fired</u>. Burners shall be modulating power type suitable for use with natural or propane gas, as required. The burners shall be capable of modulating turndown of at least 8 to 1 and shall have an intermittent spark pilot ignition system with 100 percent shutoff. The heat exchanger shall be of 3 or 4 pass design consisting of 400 series stainless steel primary drum heat exchanger with multitube secondary heat exchanger.

2.7.05 <u>Filter Section</u>. Filter sections for makeup air units shall be of the flat or angular arrangement and shall be selected to limit the filter velocity to 350 feet per minute (1.5 m/s) at design conditions unless otherwise indicated in the schedules on the drawings. Access doors shall be provided for removal of filters from either side of the section. The filters shall be 2 inch (50 mm) pleated type and shall conform to the Air Filters paragraph.

2.7.06 Controls. Each unit shall be furnished with a complete control system consisting of fan starters and overload devices, an airflow proving switch, control circuit fuses, an electronic discharge air temperature sensor and controller, and a disconnect switch. Controls shall be suitable for interfacing with and enacting the control sequence and concept indicated on the drawings. The controls shall include controls to lock out the burner when the outside air temperature is above the controller setpoint.

A remote control station shall be furnished with the makeup air unit and located where indicated on the drawings. The control station shall allow for remote operation of the unit with a fan "On-Off" switch, a "Winter-Summer" switch, a supply temperature setpoint adjustment, and indicating lights for fan, heat, lockout, and dirty filters. Where indicated in the sequence of operations, a room override thermostat shall be mounted on the panel.

Unit mounted panels shall house adequately sized combination starters rated in accordance with NEMA standards, and dead-front 3 lock nonfused disconnect switches.

2.7.07 Accessories. Makeup air units indicated or shown to be curb mounted shall be furnished with a roof mounting curb. The curb shall be constructed of 14 gage (1.9 mm) thickness zinc-coated steel with a nominal 2 by 4 inch (50 by 100 mm) wood nailer strip and with supply air opening as indicated on the drawings. The curb shall be a minimum of 16 inches (400 mm) high. The curb shall be approved by the National Roofing Contractors Association.

2.8 FANS. Each fan shall be complete with an electric motor, a drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower (7.5 kW) motors and fixed sheaves for 10 horsepower (7.5 kW) and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

Fan drive motors and controls shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the drawings.

Fans indicated in the schedules on the drawings to be explosionproof shall be suitable for installation in a NEC Class I, Division 2, Group D environment.

The external static pressure values indicated in the schedules on the drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column (0.087 kPa) shall be used for pleated filter losses.

A solid-state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp (0.4 kW) to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

Where indicated in the schedules on the drawings, fans shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.8.01 Cabinet Fans. Cabinet fans, denoted by the symbol "CF" and an identifying number, shall be Greenheck "Model SP" or "Model CSP", Penn Ventilator, Loren Cook, or approved equal. Cabinet fans shall have steel, forward-curved, squirrel-cage type wheels. The fans shall be statically and dynamically balanced. Motors shall be open dripproof, PSC, with permanently lubricated ball bearings and internal thermal overload protection, and shall be suitable for use with the power supply indicated in the schedules on the drawings. Fan housings shall be fabricated of heavy gage carbon steel with welded seams and shall be acoustically lined and factory primed. Fans shall be installed in the configuration indicated on the drawings. A removable access panel or exhaust grille shall be provided on the bottom of each fan and a factory installed backdraft damper shall be provided on the fan discharge. Vibration isolator units and wall caps shall be provided for each fan as indicated in the schedules on the drawings.

2.8.02 Duct Fans. Duct fans, denoted by the symbol "DF" and an identifying number, shall be Greenheck "SQ", Penn Ventilator, Loren Cook, or approved equal. Duct fans shall be of the centrifugal in-line type, and shall be direct or belt driven, as indicated in the schedules on the drawings. Fan wheels shall be aluminum, backward inclined type, dynamically and statically balanced at the factory.

The fan housing shall be square, constructed of aluminum or heavy gage steel as required, and shall be furnished with duct mounting collars. Access doors or panels shall be provided for servicing internal parts without removing the fan from the ductwork. Vibration isolation units shall be provided for each unit. The interior of the fan housing shall be lined with 1 inch (25 mm) fiberglass duct liner.

Motors and drives shall be isolated from the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, permanently sealed pillow block bearings.

Flexible wiring leads shall be provided from the fan motor to an external junction box and disconnect switch which shall be accessible for servicing without disconnecting the field wiring.

2.8.03 Fume Hood Exhaust Fans. Fume hood exhaust fans and exhaust duct stackheads, denoted by the symbol "EF" and an identifying number, shall be manufactured by Kewaunee Scientific Equipment Corporation, or approved equal. Fume hood exhaust fans shall be of the single inlet, multiblade, flat or backward-inclined centrifugal type and shall be statically and dynamically balanced at the factory.

Fans shall be furnished with removable weather covers over the motors, drive shaft, and bearings. Each fan shall be furnished with vertical exhaust duct stackheads, and NEMA Type 3R disconnect switches.

Exhaust fan outlets shall consist of a duct stackhead and a transition section that fits directly onto the outlet of the exhaust fans. The duct stackhead shall be a zero pressure vertical stack weather cap designed to keep water out of the fan housing. Stackheads shall be rigidly supported as indicated on the drawings. The stackheads shall be fabricated of cold rolled steel, coated with a baked, chemical-resistant, synthetic resin finish, or fabricated of AISI Type 316 stainless steel. The exhaust stack shall be fabricated with all seams welded and ground smooth.

The fans shall be sized to fit in the space indicated on the drawings and shall be provided with vibration isolators, threaded 1/4 inch (6 mm) drain connections at the low point of the scrolls, and inlets suitable for attaching flexible connections to the fans.

The exhaust fans shall have welded housings and steel frames with a baked, chemical-resistant finish. Fan wheels shall be of steel and shall be coated with a baked, chemical-resistant finish, "Kem-FP" or approved equal.

2.8.04 Power Roof Ventilators. Power roof ventilators, denoted by the symbol "PRV" and an identifying number, shall be Greenheck "G" or "GB", Penn Ventilator "Domex", Loren Cook, or approved equal.

Power roof ventilators shall be centrifugal or propeller type, as indicated in the schedules on the drawings, and shall be statically and dynamically balanced for quiet, vibration-free operation. Each fan shall be complete with a weather hood, a safety disconnect switch mounted in the hood, a 1/2 inch (13 mm) mesh aluminum bird screen over all openings, and, where indicated in the schedules on the drawings, a backdraft damper. Fan housings shall be constructed of aluminum and shall have an aluminum base of the self-flashing type, suitable for mounting on the curbs indicated on the drawings.

2.8.05 Propeller Fans. Propeller fans, denoted by the symbol "PF" and an identifying number, shall be Greenheck "Model S" or "Model SC" for direct drive and "Model SB" or "Model SBC" for belt drive, Penn Ventilator, Loren Cook, or approved equal.

Propeller fans shall consist of a panel frame, a wire guard, a motor, and fan blades. Fan blades shall be steel or aluminum, as required. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.

When indicated in the schedules on the drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, backdraft damper, and weather hood with birdscreen.

2.8.06 Utility Fans. Utility fans, denoted by the symbol "UF" and an identifying number, shall be Greenheck "Model SWB", Penn Ventilator, Loren Cook, or approved equal.

Utility fans shall be multiblade, squirrel-cage type, with nonoverloading type blades. The fans shall be statically and dynamically balanced for quiet, vibration-free operation and shall be provided with vibration isolators. Fan inlets and outlets shall be provided with removable angles and bolts for attaching flexible connections. Fan housings shall be heavy gage steel, of all-welded construction and shall be shop coated with universal primer. Fan bearings shall be of the self-aligning, ball type.

2.8.07 Vaneaxial Fans. Vaneaxial fans, denoted by the symbol "VF" and an identifying number, shall be manufactured by Aerovent, Buffalo Forge, or approved equal. Vaneaxial fans shall have heavy gage steel housings with straightening vanes and adjustable blades. Fans shall be direct connected to an electric drive motor suitable for use with the power supply indicated in the schedules on the drawings. The fans shall be furnished with inlet bells, inlet and outlet screens, and support legs for mounting vertically or horizontally, as indicated in the drawings. The support legs shall be constructed of heavy steel plate attached to the fan housing and braced for rigidity. Each fan shall be equipped with access doors for blade adjustment and vibration isolators.

2.8.08 Wall Fans. Wall fans, denoted by the symbol "WF" and an identifying number, shall be Greenheck "Model GW" or "Model GWB", Penn Ventilator, Loren Cook, or approved equal. Wall fans shall be suitable for sidewall installation; shall be direct or belt driven, centrifugal type, with aluminum wheels and housing, and a wheel guard located on the discharge side; and shall be statically and dynamically balanced at the factory. The fan motors shall be of adequate size to prevent overloading when operating at the specified capacity and shall be suitable for use with the power supply indicated in the schedules on the drawings.

2.8.09 FRP Fans. Fans to be used in FRP applications shall be as manufactured by Plasticair, or approved equal.

2.9 ROOF HOODS. Roof hoods, denoted by the symbol "RH" and an identifying number, shall be Greenheck "Model FHI" or "FHR", Penn Ventilator, Loren Cook, or approved equal.

Roof hoods shall be suitable for air intake or exhaust and shall have throat dimensions as indicated in the schedules on the drawings. The roof hood assembly shall be constructed of galvanized steel or aluminum. Each roof hood shall be complete with a weather hood, a 1/2 inch (13 mm) mesh aluminum or galvanized bird screen over all openings, and a mounting base suitable for installation on a curb as indicated on the drawings.

Where indicated in the schedules on the drawings, roof hoods shall be given a protective coating resistant to the corrosive atmosphere indicated.

2.10 AIR TERMINAL UNITS. Air terminal units shall include a sheet metal casing, volume dampers, an air volume sensing device, actuators, acoustical lining, sound baffles and accessory controls. The actuators type shall be as required. The acoustical lining shall conform to UL-181 and NFPA-90A. Enclosures of terminal units shall be constructed of galvanized steel not lighter than 22 gage (0.76 mm) thickness or aluminum sheet not lighter than 18 gage (1.21 mm) thickness. Single or multiple discharge outlets shall be provided as indicated on the drawings.

Terminal units shall be pressure independent and shall maintain a calibrated set or varying airflow rates with varying inlet static pressures. Unit air volume shall be factory preset and shall be readily field adjustable without special tools. Pressure losses through the unit at maximum flow rate shall not exceed the values indicated in the schedules on the drawings.

Acoustic performance of the terminal units shall be based upon units tested in accordance with ARI 880. Certified discharge and radiated sound power data for the units giving dB referenced to 10^{-12} watts in each of the octave bands shall be included with the air terminal unit submittal. Discharge sound power shall be shown for a pressure range from minimum up to the inlet static pressure as required. Radiated sound shall be indicated without allowance for ceiling absorption.

2.10.01 Coils. Heating water coils shall be furnished and installed where indicated on the drawings. The coils shall be fin-and-tube type, constructed of seamless copper tubes with copper or aluminum fins mechanically bonded or soldered to the tubes. Casing and tube support sheets shall be 16 gage (1.52 mm) thickness or 0.0635 inch (1.6 mm), galvanized steel, formed to provide structural strength. Each coil shall be designed for 150 psig (1035 kPa gauge) working pressure and shall be tested at an air pressure not less than 250 psig (1725 kPa gauge).

Electric resistance heating coils shall be duct-mounted type consisting of a nickel-chromium resistor mounted on refractory material and a steel or aluminum frame for attachment to ductwork. Electric duct heaters shall meet UL requirements and shall be provided with a built-in or surface-mounted high-limit thermostat. Electric duct heaters for use with fan-powered air terminal units shall be interlocked electrically so that heaters cannot be energized unless the fan is running.

2.10.02 Controls. Unit operators and controls shall be provided by the temperature controls supplier and shall be factory-installed by the air terminal unit manufacturer. The air terminal units will receive a control signal from the temperature control system and shall be furnished with controls to provide proper system operation. Controls shall include an automatic changeover control when heating and cooling air is supplied to the unit. The signal will modulate the primary air valve and the heating output as described in the sequence of operation.

2.10.03 Air Terminal Units - Single Duct. Single duct air terminal units, denoted by the symbol "ATS" and an identifying number, shall be Price, Environmental Technologies "Model SDR", Titus, or approved equal.

Constant volume, single duct terminal units shall be equipped with a mechanical or pneumatic constant volume regulator. The units shall control air volume within ±5 percent of each air set point volume as determined by the thermostat with variations in inlet pressures from 0.50 to 6 inch wc (0.12 to 1.5 kPa).

Variable volume, single duct, low pressure terminal units shall be provided with a calibrated air volume sensing device, an air valve or damper, an actuator, and accessory relays. External differential pressure taps (separate from the control pressure taps) shall be provided for air flow measurement with a 0 to 1 inch wc (0 to 0.25 kPa) range. Unit volume controller shall be normally open or closed, as required, upon loss of the control signal.

2.10.04 Air Terminal Units - Fan Powered. Fan powered air terminal units, denoted by the symbol "ATF" and an identifying number, shall be Price, Environmental Technologies "Model VVF-II", Titus, or approved equal.

Variable volume, single duct, low pressure, fan-powered terminal units shall be provided with a calibrated air volume sensing device, an air valve or damper, an actuator, a fan and motor, and accessory relays. The units shall control primary air volume to within ±5 percent of each air set point as determined by the thermostat with variations in inlet pressure 0.5 to 6 inches wc (0.12 to 1.5 kPa). The unit fan shall be centrifugal, direct-driven, double-inlet type, with forward curved blades. The fan motor shall be permanently lubricated, permanent split-capacitor type. The fan speed shall be controlled by a solid-state speed controller to balance the fan airflow rate to the specified rates. The fan/motor assembly shall be isolated from the casing to minimize transmission of vibration. The fan control shall be factory furnished and wired into the terminal unit's control system. A factory-mounted pressure switch shall be furnished to operate the unit fan whenever pressure exists at the unit primary air inlet or when the control system fan operates.

2.11 DAMPERS.

2.11.01 Backdraft Dampers. Backdraft dampers, denoted by the symbol "BDD", shall be Arrow United Industries "Type 655", Ruskin "BD6", or approved equal. Backdraft dampers shall be constructed with a 1 by 4 inch by 0.081 inch thick (25 by 100 mm by 2 mm) extruded aluminum frame. Blades shall be of 0.081 inch (2 mm) aluminum, with silicone rubber seals on the edges, and with aluminum shafts and ball bearings.

2.11.02 Control Dampers. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet (2.3 m^2) or with any dimension exceeding 48 inches (1200 mm) shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit.

Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

Control dampers shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.11.02.01 Duct Mounted Control Dampers. Control dampers and face bypass dampers mounted in ductwork and equipment curbs shall be Arrow United Industries "Type AFD-20", Ruskin "CD-50", or approved equal. The damper frames shall be constructed of 5 inch (125 mm) Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch (150 mm) wide airfoil-shaped extruded aluminum.

Control dampers denoted on the drawings to be face and bypass dampers shall be vertically arranged. The face damper dimensions shall be coordinated with the heating coil dimensions. The bypass area shall be half the area of the face damper. Face and bypass damper submittals shall indicate coil size, face dimensions, and bypass dimensions.

2.11.02.02 Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Ruskin "CD-40", Arrow United Industries "Type AFD-20", or approved equal. Control damper frames shall be constructed of 4 by 1 inch (100 by 25 mm) 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch (100 mm) wide airfoil-shaped extruded aluminum.

2.11.02.03 Round Control Dampers. Round control dampers shall be Arrow United Industries "Type 70, 75, or 80", or approved equal. The damper frames and blades shall be constructed of the material as required.

2.11.03 Fire Dampers. Fire dampers, denoted by the symbol "FD", installed in partitions having a fire resistance rating of less than 3 hours shall be Air Balance Inc. "Model D19", Ruskin "Model DIBD2", or approved equal. Fire dampers installed in partitions having a fire resistance rating of 3 hours or more shall be Air Balance Inc. "Model D39", Ruskin "Model DIBD23", or approved equal. Fire dampers shall be style "B" for ducted and style "A" for non-ducted applications unless otherwise indicated on the drawings.

Dampers shall have a 5 inch (125 mm) wide galvanized steel channel frame, galvanized steel interlocking blades, stainless steel closure springs and latches, 165°F (74°C) fusible links, and a 20 gage (0.91 mm) thickness galvanized steel housing. Factory fabricated sleeves and mounting angles shall be furnished for each damper for mounting as indicated on the drawings. Fire dampers shall be rated in accordance with UL-555 for use in dynamic systems.

2.11.04 Smoke Dampers. Smoke dampers, denoted by the symbol "SCD" and an identifying number, shall be Air Balance Inc. "Series S", Ruskin, or approved equal. The damper leakage class shall be as required.

Damper frames shall be fabricated of 16 gage (1.52 mm) thickness, 5 inch by 1 inch (125 by 25 mm) galvanized steel channel and shall be sized to fit the ductwork as indicated on the drawings. Blades shall be parallel, 16 gage (1.52 mm) thickness galvanized steel, and shall be furnished with blade and jamb seals. Smoke dampers shall meet all applicable provisions of UL-555S and shall bear the UL label.

Axles and control shafts shall be of 1/2 inch (13 mm) plated steel, with oil impregnated bronze bearings. Linkages shall be concealed and shall be located outside the airstream.

2.11.05 Combination Smoke/Fire Dampers. Combination smoke/fire dampers, denoted by the symbol "SFD" and an identifying number, shall be Air Balance Inc. "Model FS2", Ruskin, or approved equal.

Combination smoke/fire damper frames shall be fabricated of a 16 gage (1.52 mm) thickness, 5-1/2 by 7/8 inch (140 by 22 mm) galvanized steel channel, interlocking 16 gage (1.52 mm) thickness galvanized steel blades, and an 18 gage (1.21 mm) thickness galvanized steel sleeve. The sleeve shall be at least 6 inches (150 mm) longer than the thickness of the wall or floor in which the damper is installed. Bearings shall be oil-impregnated bronze. Blade edge seals shall be high-temperature silicone rubber.

Each damper shall be provided with a matching UL-approved, factory installed electric actuator with 165°F (74°C) thermal disc. The actuator shall be installed for power-open/spring-return (fail closed) operation. The actuator shall be suitable for 120 volt single phase power supply and shall be rated for a temperature of 250°F (121°C).

Combination smoke/fire dampers and actuators shall meet all applicable provisions of UL-555 and shall bear the UL label. Dampers shall be rated 1-1/2 hour, leakage class II, and temperature class of 250°F (121°C).

2.11.06 Volume Control Dampers. Volume control dampers shall be denoted by the symbol "VCD". Volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD", Ruskin "Model MDRS25", or approved equal. Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770", Ruskin "Model MD35", or approved equal.

Rectangular volume control dampers shall be fabricated of 16 gage (1.52 mm) thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch (100 mm or 125 mm by 25 mm) channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch (178 mm) long, 22 gage (0.76 mm) thickness frame, and a minimum 20 gage (0.91 mm) thickness circular blade.

The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

2.12 DAMPER OPERATORS. The damper operators shall be direct coupled or linkage type. Where linkage type operators are used, each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

Each operator shall have sufficient torque to operate the connected control damper area. Each damper operator shall have at least a 50 inch-pound (5.6 N-m) normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators shall be furnished to produce the normal running torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the drawings. Face dampers shall fail to the closed position and bypass dampers to the open position.

Where damper operators are installed in explosionproof rated areas indicated on the drawings, the operators shall be furnished and installed in explosionproof housings suitable for installation in an NEC Class I, Division 2, Group D area. Where damper operators are installed outdoors, the operators shall be furnished and installed in weathertight enclosures.

2.12.01 Electric Damper Operators. The electric damper operators shall be two-position or modulating type, as indicated in the sequence of operation or schedules on the drawings.

2.12.01.01 Modulating Electric Damper Operators. Modulating electric damper operators shall be Honeywell "Model M9185", or approved equal. Modulating electric damper operators in hazardous areas shall be installed in Honeywell "ES-650-118" explosionproof housing, or approved equal.

Modulating electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch (9.5 mm) square, double-ended drive shaft.

Damper operators shall be electrically operated, reversing, proportional operators with spring return, and internal single pole-double throw auxiliary switch rated 5 amperes at 120 volts ac.

Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers where required, shall be factory wired to the damper operator and installed in a NEMA Type 1 enclosure fastened to the motor housing.

2.12.01.02 Two-Position Electric Damper Operators. Two-position direct coupled electric damper operators shall be Belimo "NF120-S", Honeywell "ML4195", Johnson Controls, or approved equal. Linkage type electric damper operators shall be Honeywell "Model M4185", Johnson Controls "Model M100", or approved equal. Two-position electric damper operators in hazardous areas shall be installed in explosion proof housings.

Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA Type 1 enclosure fastened to the motor housing.

a. Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable. The operators shall be suitable for direct mounting to shafts up to 1 inch (25 mm) and shall be complete with mounting brackets and damper position indicator.

b. Linkage type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch (9.5 mm) square, double-ended drive shaft.

2.12.02 Pneumatic Damper Operators. The pneumatic damper operators shall be two-position or modulating type as indicated on the drawings. Each operator shall be provided with factory-mounted pilot positioners.

2.12.02.01 Two-Position Pneumatic Damper Operators. Two-position pneumatic damper operators shall be housed in a die-cast aluminum case with a mounting flange. Pneumatic operators shall be piston type, with a 3/8 inch (9.5 mm) square, double-ended drive shaft.

Pneumatic operators shall have a spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac.

2.12.02.02 Modulating Pneumatic Damper Operators. Modulating pneumatic damper operators shall be housed in a die-cast aluminum case with a mounting flange. Pneumatic operators shall be piston type, with a 3/8 inch (9.5 mm) square, double-ended drive shaft.

Modulating pneumatic damper operators shall be reversing type.

2.13 AIR OUTLET AND INLET DEVICES. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, Titus, or approved equal. Air outlet and inlet devices shall be furnished and installed where indicated on the drawings.

Air outlet and inlet devices shall be given a protective coating identical to the coating applied to the connected ductwork and equipment.

2.13.01 Linear Diffusers. Linear diffusers shall be constructed of aluminum or steel as indicated in the schedules on the drawings. All linear supply diffusers shall have adjustable air pattern control.

2.13.02 Ceiling Diffusers. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the drawings. Size, location, and direction of airflow shall be as indicated on the drawings.

2.13.03 Registers and Grilles. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

2.14 FLEXIBLE CONNECTIONS. Flexible connections located indoors shall be Ventfabrics "Ventglas", or approved equal. Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon", or approved equal.

Ductwork connections to the air handling equipment, and where indicated on the drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches (76 mm) of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20 to 180°F (-29 to 82°C) and shall weigh at least 27 ounces per square yard (915 g/m^2).

Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10 to 250°F (-23 to 121°C) and shall weigh at least 24 ounces per square yard (814 g/m^2).

2.15 AIR FILTRATION EQUIPMENT.

2.15.01 Pleated Air Filters. Pleated air filters shall be American Air Filter "AM-AIR 300X", Farr "30/30", or approved equal. Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have an average efficiency of 25 to 30 percent based on the ASHRAE 52.1 test method.

One inch (25 mm) filters shall have at least 14 pleats per linear foot (0.3 m) and at least 1.9 square feet of media per square foot of filter area (1.9 square meters per square meter). One inch (25 mm) filters shall have a maximum initial resistance of 0.10 inch wc at 300 feet per minute (0.02 kPa at 1.5 m/s).

Two inch (50 mm) filters shall have at least 12 pleats per linear foot (0.3 m) and at least 4.2 square feet of media per square foot of filter area. (4.2 square meters per square meter). Two inch (50 mm) filters shall have a maximum initial resistance of 0.13 inch wc at 300 feet per minute (0.03 kPa at 1.5 m/s).

2.15.02 Extended Surface Air Filters. Extended surface air filters shall be American Air Filter "VariCel II", Farr "Riga-Flo", or approved equal. Filters shall be of the disposable type with glass fiber or synthetic media pack. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. Extended surface air filters shall have an average efficiency of 60 to 65 percent based on the ASHRAE 52.1 test method. Filters shall have a maximum initial resistance of 0.40 inch wc at 500 feet per minute (0.10 kPa at 2.5 m/s).

2.15.03 Side Access Filter Housings. Side access filter housings shall be American Air Filter "Access Air", Farr "Model 4P Glide/Pack", or approved equal. Side access filter housings shall be single-stage, factory-fabricated of 16 gage (1.52 mm) thickness galvanized steel and shall be equipped with flanges for connection to the ductwork. Access doors shall be 16 gage (1.52 mm) thickness galvanized steel and shall be positioned to allow replacement of filters from either side of the housing. Filter housings and doors shall be insulated and of double-wall construction. Filter tracks shall be provided to accommodate nominal 2 inch (51 mm) thick disposable filters as described herein. Leakage at the rated airflow shall be less than 1 percent at a 3 inch wc (0.75 kPa) differential.

2.16 AIR FILTER MONITORING EQUIPMENT. Air filter monitoring equipment in the form of draft gauges and shaft power monitors shall be installed within all air distribution systems. The Contractor shall be responsible for equipment installation in accordance with the Manufacturers instructions. Furthermore, the Contractor will be responsible for start-up, testing, and operation and maintenance training of the Owner’s personnel.

2.16.01 Draft Gauges. Draft gauges shall be Dwyer Instruments, Inc. "2000 Series Magnehelic Air Filter Gauge", or approved equal.

Diaphragm actuated dial type draft gauges, located for easy readability, shall be installed across all air filters. The gauges shall have a dial of at least 3-1/2 inch (89 mm) diameter, a die cast aluminum housing, an adjustable signal flag, mounting hardware, an ambient temperature range of 20 to 140°F (-7 to 60°C), and a range of 0 to 1.0 inch wc (0.25 kPa), with a full range accuracy of 2 percent. Each gauge shall be furnished with an air filter kit consisting of a mounting panel, two static pressure tips with integral compression fittings, aluminum tubing, and vent valves.

2.16.02 Shaft Power Monitors. Shaft power monitors shall be Emotron “EL-FI M20” or approved equal.

Shaft power monitors shall at minimum include a system that is suitable for installation within the air filter electrical control panel. Shaft power monitors shall provide two (2) programmable alarm outputs for detecting overload and underload conditions. The system will provide user information via an on-board alpha-numeric display, which may be in the form of an LCD or LED. Alarm Status should be displayed. A DIN Rail mounted device is preferable. A panel mount kit should be available as an option. The system shall derive its power supply from the same source as that required for the air filter motor, i.e., the system must not require the provision of low voltage supplies, such as 110 VAC or 24 DC. To facilitate expanded plant wide monitoring and analysis, i.e., a SCADA system, the Air Filter Monitoring and Protection System must provide a self-powered, 2-wire, 4-20mA output signal that is proportional to the load on the air filter.

Shaft power monitors shall be installed no further than 25 radial feet (7.6 m) away from corresponding air units. The unit display shall be visible within the control panel or equipment setting. If multiple air handling units are to be installed, then all output signals and alarms relating to clogged or unclogged status shall be sent to a local PLC. This signal shall also be transferred to the main facility control panel. The system shall provide the user the ability to remotely reset an alarm condition that is initiated by the system. I/O connections shall be made in accordance with Master Specifications Section 17500, Programmable Logic Controllers.

2.17 SHEET METAL WORK. The ductwork, accessories, bracing, and supports shall be constructed of the material as required. Galvanized ductwork located in air conditioned spaces shall be constructed of G-60 or better lockforming quality in accordance with ASTM A653. All other galvanized ductwork shall be constructed of G-90 or better galvanized steel. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Plenums shall be constructed of reinforced 16 gage

(1.52 mm) thickness galvanized sheet metal.

Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch (25 mm).

Sheet metal fan boxes shall be fabricated with 12 gage (2.66 mm) thickness galvanized sheet metal skin and structural steel framing of sufficient strength to support the fan box and the fan mounted on the box. The framing shall be coated with a universal primer. All welds on galvanized metal shall be cleaned and coated with a zinc-rich paint. Drawings of the fan boxes shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

Sheet metal ductwork for the laboratory exhaust systems shall be constructed of AISI Type 304 stainless steel with standard mill finish. Longitudinal seams and transverse joints shall be made with continuous welds. The welding procedure shall produce joints with corrosion resistance at least equal to that of the base material. Duct thickness shall be as needed for the welding procedure, but shall not be less than 22 gage (0.76 mm) thickness. Flanged connections shall be provided at all equipment and damper connections, and at intervals not more than 10 feet (3 m) as measured along the centerline of the duct. Flanged joints shall be provided with 1/8 inch (3.2 mm) thick viton gaskets suitable for temperatures up to 250°F (121°C).

All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

Where indicated on the drawings, ductwork and accessories shall be given a protective coating resistant to the corrosive atmosphere.

2.18 DUCT INSULATION. Interior duct liner shall be Knauf "Duct Liner E M", CertainTeed "ToughGard R", Schuller "Permacote-Linacoustic", or approved equal.

Interior duct liner shall be 1-1/2 pound per cubic foot (24 kg/m^3) density, spray coated duct liner with an "R" value of at least 3.6 ft^2·hr· °F/BTU (0.63 m^2· C/W) per inch (25 mm) thickness. The insulation shall be suitable for temperatures up to 250°F (121°C) and shall have at least a 0.55 NRC per 1 inch (25 mm) thickness. The insulation shall conform to ASTM C1071.

2.19 FLEXIBLE DUCT AND TAKEOFFS. Flexible duct shall be Flexmaster "Type 9", Flexible Technologies "Thermaflex Type G-KM", or approved equal. Takeoffs shall be Buckley Air Products "Air-Tite Bellmouth BM-D", or approved equal.

Flexible duct shall be a galvanized or vinyl-coated spring steel helix, bonded to a polymer liner, and wrapped with glass fiber insulation suitable for use in heating and cooling systems. The insulation shall provide an "R" value of at least 4.2 $ft^2 \cdot hr \cdot$ °F/BTU (0.74 $m^2 \cdot$ C/W). The outer jacket shall be a vapor barrier of fire retardant polyethelene or polyolefin material. The flexible duct shall be listed under UL 181 as Class 1 flexible air duct and shall comply with the latest edition of NFPA 90A.

Takeoffs for the flexible duct shall be bellmouth type manufactured of galvanized steel with a neoprene gasket and predrilled holes. Each takeoff shall be equipped with a balance damper constructed of 26 gage (0.45 mm) thickness galvanized steel. Scoops or other obstructions in the main duct will not be acceptable.

2.20 ACCESS DOORS. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

2.21 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

2.22 DRIVE UNITS. Drive units shall be designed for 24 hour continuous service.

2-22.01 Adjustable Frequency Drives. Adjustable frequency drives (AFD) shall be provided as indicated in the schedules on the drawings. Each adjustable frequency drive shall be coordinated with the requirements of the driven equipment. Particular attention shall be directed toward the driven equipment torque requirements.

The equipment supplier shall be responsible for coordinating the AFD with the driven equipment to assure compatibility between the drive and motor. All equipment shall be derated as recommended by the AFD and motor manufacturers for reduced speed operation with an adjustable frequency controller.

Each AFD shall be pulse-width modulated type and shall produce an adjustable ac voltage/frequency output. Each AFD shall maintain a minimum displacement power factor of 0.95 over the entire speed range, and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

Each AFD shall be equipped with an input line reactor and a full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a fixed dc voltage.

The AFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) which shall be controlled by six identical base driver circuits. The AFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. Each AFD shall be configurable for automatic and manual reset and shall have an adjustable carrier frequency to at least 16,000 Hz.

2.22.02 V-Belt Drives. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.6 at maximum speed based on the nameplate horsepower (kW) of the drive motor.

2.22.03 Safety Guards. All belt drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage (1.52 mm) thick or thicker galvanized or aluminum-clad sheet steel or from 1/2 inch (12.7 mm) mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

2.22.04 Electric Motors. Motors furnished with equipment shall meet the following requirements.

a. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

b. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

c. Rated for continuous duty at 40°C ambient, unless the application is well recognized for intermittent duty service as a standard industry practice.

d. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

e. To ensure long life, motors shall have nameplate horsepower (kW) equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Open	1.15
	Other Than Open	1.0
Integral hp (kW)	Open	1.15
	Other Than Open	1.0

f. Designed for full voltage starting.

g. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

h. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

i. Bearings shall be either oil or grease lubricated.

j Totally enclosed motors shall be furnished on:

1. Outdoor equipment.

2. Equipment for installation below grade.

3. Equipment operating in chemical feed and chemical handling

locations.

4. Equipment operating in wet or dust-laden locations.

k. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

l. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

m. Motors shall be rated as follows:

1. Below 1/2 hp (0.4 kW).
115 volts, 60 Hz, single phase; or 240 volts, 60 Hz, single phase.

2. 1/2 hp (0.4 kW) and above.
460 volts, 60 Hz, 3 phase.

Motors used on 240 volt systems shall be 230 volts, 60 Hz, 3 phase.
Motors used on 208 volt systems shall be 200 volts, 60 Hz, 3 phase.

n. All motors shall meet the minimum efficiency standards required by the Energy Policy Act (EPACT) of 1992.

o. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

p. Motors to be used with adjustable frequency drives shall be rated for inverted service.

2.23 SHOP TESTING. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, ARI, NBS, NFPA, and UL Standards.

2.24 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in pounds
N = RPM for N greater than 1,000

At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be more than 1.3.

2.25 FRP DUCTWORK.

2.25.01 Material. Fiberglass reinforced polyester resin; complying with ASTM C581. Do not add thixotropic agent to resin.

2.25.02 Corrosion Liner. Consists of one “C” veil and one chopped strand mat (1-1/2 ounces) or one layer of chopped strand prior to filament winding. Provide minimum 30 mil thickness.

2.25.03 Duct Wall Thickness. Minimum 1/4 inch.

2.25.04 Fittings. Provide smooth bends or internal turning vanes at elbows, tees and at other changes in direction.

2.25.05 Suction Inlet. Provide suction inlet with vinyl coated screen; 50 percent free area.

2.25.06 Flanges. Comply with ASTM D4024 and PC15-69, Sections 3.4.7.1 to 3.4.7.5.

2.25.07 Fabrication. Comply with Voluntary Product Standard PS15-69, Sections 3.1.1 to 3.4.9. Fabricate for water drainage.

2.25.07.01 Visual Defects. Comply with ASTM D2563, Level II.

2.25.07.02 Exterior Coating. Comply with PS-15-69, Section 3.3.3.1.

2.25.07.03 Duct Deflection Rectangular Duct. Rectangular Duct: Not to exceed 2 percent of the width of the side at a test vacuum pressure of 6 inch wc.

2.25.07.04 Duct Deflection Round Duct. Not to exceed 2 percent or “S” of duct diameter under an impolsed hoop (point) loading of 550 pounds.

2.25.08 Duct Supports. Provide at least every 5 feet; fabricated of galvanized steel.

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION.

3.2.01. Field Measurement. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

3.2.02 Surface Preparation. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of topcoats.

Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in Master Specification Section 09900, Painting.

3.3 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

The space beneath baseplates shall be grouted as specified in Master Specification Section 03600, Grout.

3.3.01 Air Handling Units. Flexible connections shall not be in tension when the fans are operating.

3.3.02 Coils. Hydronic coils shall be installed level, except for drainable coils which shall be installed with a pitch toward the drain end of the coil. Hydronic coil piping shall be arranged with the supply connection at the bottom of the coil and the return connection on the top. The water supply connection shall be toward the leaving side of the air coil for counterflow arrangement.

A sight glass shall be installed in the liquid line adjacent to each refrigerant coil. Where air handling units are installed on vibration isolators, flexible connectors shall be installed in the coil piping.

3.3.03 Makeup Air Units. Flexible connections shall not be in tension when the fans are operating.

3.3.04 Fans. Flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

Power roof ventilators shall be secured with corrosion resistant lag screws to the roof curb.

3.3.05 Roof Hoods. Roof hoods shall be secured with corrosion resistant lag screws to the roof curb.

3.3.06 Air Terminal Units. Each air terminal unit shall be individually supported from the building structure.

3.3.07 Dampers. Fire, smoke, and combination fire/smoke dampers and smoke dampers shall be furnished and installed where indicated on the drawings and as specified by NFPA 90A. All dampers shall be installed in accordance with the manufacturer's UL installation instructions.

Fire dampers shall be installed square and free from racking with blades horizontal. Fire damper frames shall not be compressed or stretched into duct or opening and shall be handled using the sleeve or frame. Where multiple section assemblies are needed, bracing shall be installed to support fire damper weight and to hold assembly against system pressure.

Smoke dampers shall be mounted with the damper blades running horizontal. A duct mounted access door shall be located on the jackshaft side of each damper.

3.3.08 Damper Operators. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

3.3.09 Air Outlet and Inlet Devices. Diffusers with balance dampers installed in the flexible duct takeoffs shall not have an opposed blade damper mounted in the throat of the diffuser.

Ceiling mounted air terminals or services weighing 20 pounds (89 N) shall be supported directly from the structure.

3.3.10 Draft Gauges. Draft gauges for filters located more than 8 feet (2.4 m) above the finished floor shall be mounted on the nearest wall, 5.5 feet (1.7 m) above the finished floor. Each gauge shall be installed with vent valves in the connecting tubing adjacent to the gauge for checking and re-zeroing functions.

3.3.11 Sheet Metal Work. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards. The locations, arrangement, and sizes of ductwork shall be as indicated on the drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

Ductwork shall be constructed and installed in accordance with the drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet (2.4 m) above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch (200 mm) lighting allowance between the ceiling and the bottom of the ductwork.

In vertical ducts with a closed bottom which terminate less than 24 inches (600 mm) above finished floor, the bottom of the ductwork shall be broken and sloped to a 1/2 inch (12.5 mm) drain hole in the bottom of the duct.

Single-thickness turning vanes shall be installed in all turns with 45 degree or greater angles.

3.3.12 Duct Insulation. Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches (200 mm) on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

The following ducts shall be insulated with a 1 inch (25 mm) thick interior duct liner unless otherwise indicated or indicated on the drawings to be wrapped:

Makeup or outside air ducts.

Air conditioning system supply and return ducts.

Other ducts where indicated on the drawings.

3.3.13 Flexible Duct and Takeoffs. The length of the flexible ductwork shall not exceed 8 feet (2.4 m). All support saddles for flexible duct shall be a minimum of 6 inches (150 mm) wide.

3.3.14 Access Doors. Airtight access doors shall be provided for inspection of all control dampers, fire dampers, smoke dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches (200 mm) square for hand access, 18 inches (450 mm) for shoulder access, or as indicated on the drawings. Each access door shall be installed to open against the pressure in the duct.

Access doors at locations where smoke and fire dampers are installed shall be permanently identified on the exterior by a "Smoke Damper" or "Fire Damper" label with letters not less than 1/2 inches (12.5 mm) in height.

Access doors for fire dampers shall be located as close as possible to the damper, and be located so that the spring catch and fusible links are accessible when the damper is closed. Where the size of the duct permits, the minimum size access door shall be 18 inches by 18 inches (450 mm by 450 mm). For dampers that are too large to access from outside the duct, the door shall be a minimum of 24 inches by 18 inches (600 mm by 450 mm). Where possible, the access shall be located on the underside of the duct.

3.4 FIELD QUALITY CONTROL.

3.4.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.4.02 Startup and Testing. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.5 CLEANING. At the completion of the testing, all equipment, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15890

ODOR CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the installation and furnishing of odor control systems Included, but not limited to, are the following concepts; carbon odor control vessels, grease filter/mist eliminators, FRP fans, fan acoustical enclosure units, interconnecting ductwork, anchorage devices, tools and spare parts.

1.2 GENERAL. Contractor shall provide all labor, materials, equipment and incidentals required to furnish and install new odor control system(s) for the wastewater collection and treatment facilities.

1.2.01 Coordination. Contractor shall be responsible for coordination of the design, fabrication, and installation of the odor control system shown on the drawings and specified herein. Contractor shall coordinate the installation of the items to comply with the requirements of the Work specified under this Section.

1.2.02 General Equipment Stipulations.
Obtain all equipment included in this Section from a single carbon odor equipment manufacturer, hereon referred as the Odor Control System Supplier (OCSS), regardless of the component manufacturer. The OCSS shall review and approve or shall prepare all shop Drawings and other submittals for all components furnished under this Section. All components shall be specifically designed for odor control services and shall be integrated into the overall system by the OCSS.

1.2.03 Governing Standards. Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified:

ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
ASTM A194, Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High-Pressure and High-Temperature Service.
ASTM C581, Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures.
ASTM C582-87, Standard Specification for Contact Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosions-Resistant Equipment.
ASTM D2563-87, Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
ASTM D2583-87, Standard Test method for Indentation Hardness of Rigid Plastics by Means of Barcol Impresser.
ASTM D2584-68, Standard Test Method for Ignition Loss of Cured Reinforced Resins.
ASTM D3299-88, Standard Specification for Filament-Wound Fiberglass

Reinforced Thermoset Resin Chemical Resistant Tanks.
ASTM4097-88, Standard Specification for Contact Molded, Glass Fiber Reinforced Thermoset Resin Chemical Resistant Tanks.
ASTM E84, Standard Test Method for Surface Burning Characteristics for Building Materials.
American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
National Electric Code (NEC).
National Electrical Manufactures Association (NEMA).
National Fire Protection Association (NFPA).
Underwriters Laboratories, Inc. (UL).
National Bureau of Standards (NBS) Voluntary Product Standard PS 15-69 Custom Contact Molded Reinforced Polyester Chemical-Resistant Process Equipment.
Society of Plastics Industry (SPI) Standards of Recommended Practices for Shipping and Installation of Fiberglass Reinforced Plastic Pipe, Duct and Tanks.

1.3 QUALITY ASSURANCE.

1.3.01 Contractor Qualifications. Manufactures of carbon vessel, fan, fan enclosure, grease filter/mist elimination and ductwork shall have a minimum of 5 years of experience or producing substantially similar equipment, and shall be able to show evidence of at least 5 installations in satisfactory operations for at least 5 years in the United States.

1.3.02 Testing. Odor controls system shall be shop tested in accordance with Master Specifications Section 15990, Testing, Adjusting, and Balancing, unless otherwise specified herein.

1.3.03 Vessel shop test. Provide services of an Independent FRP Testing Inspector to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following; visual inspection to the requirement of ASTM C582 and ASTM D2563, Barcol Hardness measurements per ASTM D2583-87, acetone sensitivity test for all internal secondary bonds, glass content by ignitions loss on three cutouts per ASTM D2584, and Hydrostatic Leak Test on each vessel by filling to the top of vessel and allowing to stand for 2 hours with no visible leakage.

1.3.04 Fan Shop Test. Perform a shop test on each fan at each operating condition.

Running Test: record volume, static pressure, speed, efficiency, BHP and housing vibration.
Running time at each condition shall be a minimum of one hour
Data shall be continuously recorded

Test shall be conducted with the job motor

Acoustical test: Record octave band sound power levels (LW) IN/dB RE 10-12 W, from 63 to 8000Hz. Convert to sound pressure level dB on "A" weighted scale, at a distance of 5 ft.

Test all fans from a facility in succession.

Motor Shop Test. Each motor shall be given a complete shop test. Ship motor to the fan manufacturer following successful completion of shop tests. Test reports shall provide the following minimum information:

Starting Torque.
Efficiently at ½, ¾ and full load.
Power factor at ½, ¾ and full load.
Percent slip.
No load, running light, full load and locked rotor current.
Current balance check.
Test curves for current, voltage, brake horsepower and power factor.
Full load heat run.
Vibration check.
Temperature rises and results of dielectric tests.
Motor type and frame size.
Bearing type and lubrication medium.
Insulation and enclosure type.
Load sound pressure levels in dB on the A weighted scale at 5 feet from the motor fan end. Sound pressure levels shall be determined in accordance with the procedures of IEEE Standard 85.

1.3.05 Ductwork Shop Test. Provide services of an Independent FRP Testing Inspector to be present at the point of manufacture, upon completion of fabrication and prior to shipment, to perform or witness the following; visual inspection to the requirements of ASTM C582 and ASTM D2563, Level III, Barcol Hardness measurements per ASTM D2583, acetone sensitivity test for all internal secondary bonds and glass content by ignition loss on three counts per ASTM D2584. Repairs deemed Acceptable by Independent FRP Testing Inspector must be approved by Owner.

1.4 SUBMITTALS.

OCSS shall be responsible for preparing and reviewing submittals for all system components as specified in Section 1.3.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with Master Specification Section 01080, Project

Submittals. Submit for approval; fabrication, assembly and installation diagrams, manufacturer's literature, illustrations, paint certifications, specifications and engineering data including dimensions, materials, size and weight of all components and complete assembly, setting drawings, templates, and directions, for the installation of anchor bolts and other anchorages, drawings showing plans and sections of the equipment to demonstrate proper coordinates between components, fabrication methods, assembly, accessories, installation details, and wiring diagrams. Description of surface preparation, shop printing and finish painting system and deviations of Contract Documents. Provisions shall be included to adequately ground the carbon bed. Manufacturer shall supply adequate submittal details to demonstrate that the carbon bed will be adequately electrically grounded. Odor Control System data shall include, but not limited to; detail product information on the control and layout drawings including locations of external wiring and piping connections and mounting, and panel wiring and piping diagrams including identification of external wiring connections.

1.4.02 Test Reports. Submit results of the required shop tests and a written field test report giving the results of required field tests.

1.4.03 Record Drawings Submit complete manuals including, copies of all shop drawings, test, reports, maintenance and data and schedules, description of operation, acceptable lubricants, and spare parts information. Operations and Maintenance data shall be submitted in accordance with Master Specification Section 01160, Training and Operations & Maintenance Manuals.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING
Deliver materials to the Site to insure uninterrupted progress of the Work. Deliver anchors bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to insure not to delay Work. Store all materials in a manner that will permit easy access for inspection and identification purposes. Keep steel members off the ground using pallets, platforms and other supports. Protect equipment including packaged materials from corrosion and deterioration. Odor control vessels shall be shipped empty and all interior components shall be shipped separately. Store mechanical equipment in covered storage off the ground to prevent condensation.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS. The odor control vessel shall have the following performance specifications: Number of units, Size, Type, Bed depth, Bed velocity flow, Pressure drop, and Maximum head loss at the bed velocity flow per foot depth of packed bed.

2.2 CARBON ADSORPTION UNITS.

2.2.01 Acceptable Manufacturers. Provide odor control equipment as manufactured by one of the following: Calgon Carbon Corporation, U.S. Filter, Norit Americas, Inc., or Approved Equal

2.2.02 Activated Carbon. The activated carbon shall be virgin pelletized activated carbon, derived from bituminous coal. The activated carbon shall be suitable for the vapor phase adsorption of wastewater treatment odors. The activated carbon shall have the following specifications:

Iodine No., mg/g	1000 min
Butane Activity, weight % (per ASTM D 5742)	26 min
Hardness	95 min
Apparent Density, g/cc	0.46 – 0.49
Minimum Particle Density	3.7 mm to 4 mm pellet
H_2S Breakthrough Capacity (g H_2S removed/cc Carbon)*	0.30 min

Ignition Temperature, ^oC, minimum (per ASTM D 3466): 350

* The H_2S breakthrough capacity shall be determined using ASTM standard method D6646-01. Prior to testing, the test sample should be completely humidified by exposing the sample to a flow of humid air for at least 12 hours. Testing of 3.5 to 4 mm diameter pellets is accomplished by passing a moist (85% RH) stream of air containing 1 vol. % H_2S and the selected concentration of CO_2 through a 1.5 inch inner diameter tube with a 9" deep bed of closely packed carbon at a rate of 3,262 cc/min and monitoring to a 50 ppm H_2S breakthrough. The results are reported as grams of H_2S adsorbed per cc of carbon.

2.2.03 Odor Control Vessels Construction. Vessels shall either be contact-molded in accordance with ASTM D4097, Grade 1 or Type I, filament-wound in accordance with ASTM D3299-88, Grade 1. Portions of the vessel including joints, heads and nozzles shall be fabricated by contact molding. Contact molded laminates shall be in accordance with ASTM C582, Table 1. All laminate physical properties shall comply with requirements for laminate thickness of 3/8 inch and thicker.

All vessels shall be designed using a minimum structural safety factor of 10 to 1 for pressure and 5 to 1 for vacuum. Vessels shall have bottom knuckle reinforcement and be designed for hydrostatic head load 10-foot above the top of the inlet.

Vessel housing shall be designed for full bottom support and shall be provided with a minimum of four Type 316 stainless steel hold down lugs. All hold down lugs shall be designed to account for all anticipated loads and shall comply with local code requirements. Furnish all anchor bolts, nuts and washers which shall be Type 316 stainless steel.

The support system for carbon beds shall be as recommended by the odor control vessel supplier and approved by the Engineer. The carbon beds shall be individually supported on a polypropylene screen basket resting on each support system. The carbon bed screens and support systems shall be removable through access manways. The support system shall be a system of grating, beams and columns or equal. The support system shall be capable of withstanding a load of not less than 300 lbs./sq.ft with a deflection not greater than 1/4 –inch under any operating condition. All components of the support system shall be constructed of materials resistant to the chemical service conditions specified for corrosion. The carbon bed shall be provided with a molded fiberglass reinforced vinyl ester grating to act as a bed limiter for the lower bed. The grating shall be 1-inch thick by 2-inch by 2-inch square type to achieve a minimum free area of 75 percent. The grating shall cover the entire surface of the lower bed and shall be installed in sections that shall be removable through the access door. Cope bed limiter to match diameter of vessel. A fully seamed polypropylene screen sewn basket shall be provided to hold the activated carbon without fraying. All edges and seams shall have “piping” to reinforce the seams and edges to prevent fraying. The basket shall be of sufficient strength to hold the carbon without tearing.

2.2.04 Resins. Resins used in laminate shall be premium corrosion resistant and fire retardant brominated bisphenol. All vinylester resins are to achieve a 25 or less flame spread rating in accordance with NFPA 91. Provide products of one of the following manufacturers: Ashland Chemical Co. Hetron 992 FR with 3 % antimony trioxide, Dow Chemical Co. DeraKane 510A or 510C with 5 % antimony trioxide, Reichold, Dion 9300 FR with 5 % antimony trioxide, or approved equal.

All cut edges shall be sealed with a resin coating of the same resin as used in the fabrication. The resin shall contain paraffin.

2.2.05 Reinforcement. Synthetic surfacing veil shall be Veil-Nexus 1012 (aperture) as manufactured by Burlington Industries. Chopped strand mat shall be Type E glass, minimum 1.5 ounces per square foot, with silane finish and styrene soluble binder. Continuous roving used in chopped gun shall be Type E glass. Woven roving shall be Type E glass, nominal 24 ounces per square yard, with a 4 by 5 weave and a silane type finish. Continuous roving used for filament winding shall be Type E glass with a silane type finish, with a nominal yield of at least 110 strand yards per pound. Glass content for filament wound layers shall be 55%-70%.

2.2.06 Laminates. Laminates shall consist of a corrosion resistant resin-rich inner surface, an interior corrosion barrier, an interior structural layer, and an exterior layer. Composition specified for inner surface and interior corrosion barrier is intended to achieve optimum chemical resistance. Corrosion resistant resin-rich inner surface shall be reinforced using a single aperture Nexus synthetic veil. Minimum resin-rich inner surface thickness shall be 10-20 mils. Thixotropic agents shall not be used for this service. Glass content of resin-rich inner surface shall be 10 % plus or minus 5 % by weight. Interior corrosion barrier shall be a minimum of 100 mils of Type E glass chopped strand mat to a total of 3 oz/sqft. The interior corrosion barrier shall be applied by either the hand laid up technique, filament winding or chopper gun. Chopper gun is only permitted if an automated process is used. Manual operation of chopper gun shall not be permitted. Glass content of interior corrosion barrier shall be 25 % plus or minus 5 % by weight.

Laminate Physical Properties:

Ultimate Tensile Strength (min.PSI) ASTM Method D638:	15,000
Modulus of Elasticity Procedure A of ASTM Method D790	10 x10
Flexural Strength – (min.PSI) ASTM Method D790	22,000
Average Glass content of Completed Tanks by Ignition (%)	45

Interior structural layer shall be of sufficient thickness to meet minimum thickness requirements specified. Glass reinforcements shall be in accordance with the appropriate standards of construction. Interior structural layer shall be fabricated using either the hand lay up, filament wound technique or approved chopper gun technique. Glass content of interior structural layer shall be 60 % plus or minus 5 % by weight. In no case shall total thickness of the interior structural layer be less than 0.50 inches. Exterior layer shall be reinforced using a single “A” glass veil with a layer of surfacing “Nexus” veil followed by a clear resin rich 10 mil thick coating similar to the inner surface. Topcoat shall be pigmented parafinated get-coat with ultraviolet inhibitors. The pigmentations shall be beige. There shall be no glass fibers exposed. Vessel wall shall be reinforced around all openings and connections.

2.2.07 Curing. Each vessel shall be given a BPO-DMA cure system to increase service life. In addition, interior of vessel shall be post-cured. Post cure shall consist of an FRP vessel wall cure temperature of at least 180° F for a minimum of 4 hours. Independent of exterior ambient fabrication shop temperature, the temperature inside the vessel may have to be elevated above 180° F. At no time shall the vessel wall temperature approach 90 % of the thermal distortion temperature for the resin used Barcol readings taken after the post-cure shall not be greater than 4 points less than the resin manufacturers published Barcol readings and in no case less than 35. Where steam is used in the post-cure, no steam shall impinge on the interior surface of the vessel of the inside of any nozzle. A steam sparge pipe projecting at least 12 inches beyond the interior surface of any nozzle and 12 inches away from any wall shall be used. During steam post-curing, the vessel shall be maintained at atmospheric pressure. Alternate curing methods may be submitted for the Engineers approval. Cobalt compounds shall not be used to accelerate curing of the FRP in any way.

2.2.08 Connections. All necessary connections for piping, instrumentation, sampling, and ductwork shall be provided as shown on Drawings or required. Suitable EPDM gaskets shall be provided. Two inch drain assembly with CPVC ball valve and 2 inch over flow drain with threaded coupling and plug. Each carbon bed shall have two 11/2 inch diameter sample probes adjacent to the carbon bed which shall extend a minimum 6 inches into the carbon bed. Probes shall be adequate to provide suitable extraction of carbon samples from the carbon bed and be non-binding. Probes shall extend outside the vessel wall and be blocked off with ball valves. One additional ¾ inch diameter sample probe shall be installed in each discharge stack and shall extend down and adjacent to the other probes. Probes and ball valve shall be of CPVC construction. Carbon adsorption unit manufacturer shall provide factory mounted pipe supports for outlet air sample ports, bottom drain connection, and 3-inch wide baffle ring around the interior circumference of each carbon bed. Flanges of air inlet, air outlet and access doors shall be manufactured by hand lay up method and shall conform to NBS-PS15-69; standard dimensions for bolting, but in no case shall the thickness be less than ¾ inch thick. Flange nozzles for piping connections shall conform to ASTM D3299, all nozzles up to and including 8-inch diameter shall be reinforced with blade type gussets. Flanges for piping connections shall be ANSI 150 lb dimensions. All flanges shall be pre-drilled. Flanges shall be checked for alignment, thickness and mating prior to shipment to field. Area on the back of all flanges around each bold hole shall be the diameter of a standard washer and shall be flat and parallel to flange face. This area shall be spot faced, if necessary, to meet this requirement.

2.2.09 Hatches. Access hatches shall be provided above top and bottom of main carbon bed sections to allow easy inspection, cleaning and maintenance of carbon. Support gratings and lower carbon bed limiter shall be removable through access hatches. All access hatches shall be in easily accessible locations and coordinated with all structural columns, structural wind bracing, ductwork and piping. All access hatches shall be corrosion resistant to acidic and basic cleaning solutions. Access hatches shall be outfitted with clear PVC, removable, corrosion resistant panels, all stainless steel type 316 hardware including nuts, washers, bolts and extruded silicon gaskets. Minimum size of access doors shall be 24-inches high by 30-inches wide by ½ inch thick with not less than 18 bold hold-down assemblies. Blind flanges and access hatch doors shall be same thickness and material as flanges to which they are attached. Tolerances and flatness shall be same as for flanges. Manways shall have word” CAUTION” stenciled on in 3-inch high red block style lettering.

2.2.10 Miscellaneous. Odor control vessels shall contain the following:

A grounding system as submitted under item 1.4, Submittals.

Lifting Lugs that shall be capable of withstanding weight of empty vessel with minimum safety factor of 5 to 1. A minimum of three lugs shall be furnished per vessel. Lifting lugs shall be Type 316 stainless steel and attached to vessel wall with hand lay-up laminate equal to or greater than the vessel wall thickness.

Mounting Lugs that are suitable for mounting electrical junction boxes. Mounting lugs shall be Type 316 stainless steel and attached to the vessel wall with hand lay-up laminate equal to or greater than the vessel wall thickness.

Odor control vessel exhaust stack and any other transition pieces required. These items shall be fiberglass, reinforced vinyl ester and furnished by the odor control vessel manufacturer. All fiberglass reinforced vinyl ester ductwork shall be as specified in this Section.

Carbon Sampling Device. A One grain thief sampling device shall be provided. The device shall be a fisher Scientific Model 14-208, or approved equal.

Hydrogen Sulfide Bed Monitor. Furnish a bed monitoring system to enable plant personnel to check for the presence of hydrogen sulfide at any sample port within the carbon bed. The monitor shall be sensitive to H_2S concentrations from 0.5 ppm to 20 ppm, and visually indicate that concentration range. The hydrogen sulfide bed monitor assembly shall provide means to detect H_2S levels with the carbon bed. The monitor shall include an adjustable flowmeter and lead acetate paper color indicating disk. The monitor shall have a fitting to attach to any carbon bed sampling port. The monitor shall be manufactured by the vessel manufacturer.

Differential Pressure Gage. Provide a photohelic differential pressure gage/switch at each carbon bed (two per vessel) to measure the differential pressure through each carbon bed through the entire vessel. Gages shall be the dial type with die cast aluminum, irridite dipped for corrosion resistance. The range shall be 0 - 20 inches water gage for odor control vessel and accuracy shall be 2 percent of scale. Switches for high and low set point shall be adjustable from knobs on gage face.

Quantity	2 per unit
Type	DPDT, Rated 10A @ 120VAC
Power requirements	120 VAC
Deadband	Maximum 1 percent of full scale
Enclosure	NEMA 4X

Manufacturer: Provide products one of the following, Dwyer Instrument, Incorporated Model 3000 series Photohelic Pressure Switch/Gage or approved equal.

2.3 FIBERGLASS REINFORCED PLASTIC FAN.

2.3.01 Manufacturer. Provide fans as manufactured by one of the following, New York Blower Company, The Ceilcote Company, Hartzell Fan, Inc., or approved equal.

2.3.02 Construction. Provide fiberglass reinforced plastic fire retardant fans with an epoxy coating to protect against ultraviolet degradation. Fans shall be installed, complete with motors, drives, guards and coatings of sufficient capacity for the duty required. Fans shall operate to draw odorous air from the basin and shall exhaust air through the carbon vessel. Fans shall be tested and rated in accordance with ASHRAE 51-75 and fan shall be licensed to bear the AMCA 210 Test Code Seal, and be certified by manufacturer to deliver rated performance. Manufacturer shall provide sound power level ratings outlined in AMCA Standard 301, ratings to be the results of testing in accordance with AMCA Standard 300. For additional details refer to Master Specifications Section 15880, Air Distribution Systems.

Service conditions shall include 1) Specified number of units, 2) CFM: as specified, balanced fan cfm shall not vary from quantity listed above by more than 5 %, OCSS shall co-ordinate fan total static pressure with actual total pressure drop across the carbon material bed, 3) the OCSS shall submit the calculations of static pressure requirements certified by a registered Professional Engineer in Michigan or any other state approved by Engineer, 4) total static pressure as specified, 4), fan rpm shall be as specified, 5) fan static efficiency shall be 64.4%, 6) outlet velocity shall be not be less than specified, 7) brake horsepower shall be as specified, 8) approximate noise level on weighted scale shall be less than 80 db maximum at 5 feet, 9) Sound power levels shall not exceed the following:

Octave bands	1	2	3	4	5	6	7	8	Overall
Total Fan Power Levels	112.3	109.3	103.3	65.3	89.2	87.3	90.3	83.3	114.5

Housing: Fan housing shall be designed so that there is no air leakage through joints and seals. All bolted pieces shall be tightened by putting gasket for air tightness. Fan housing shall be corrosion resistant, fire-retardant, sold fiberglass reinforced plastic design which shall equal or exceed the ASTM En 84 Tunnel Test Rating of 30 or less with construction classification suitable for pressure range. Fan housing shall be constructed of a premium brominated bisphenol-A vinylester resin. All exterior surfaces of the fan shall have a factory applied beige pigmented, paraffinated gel-coat with UV inhibitors. All laminates shall be manufactured in accordance with National Bureau of Standards PS 15-69, ASTM C 582. All interior portions of fan housing in the air stream shall be coated with graphite impregnated resin in accordance with ASTM D 4167.

Fan Wheel: Provide backward inclined fan wheel constructed of Type 316 stainless steel with back pressure vanes adjacent to shaft seal. Surface preparation of the metal surfaces to provide a surface metal profile via degreasing, radiusing and abrasive blasting. Remove all grit or dust particles.

Fan Shaft: Shaft shall be of Type 316 stainless steel designed to operate below first critical speed. Shaft and impeller shall be statically and dynamically balanced at normal operating speed listed in schedule below to allow a maximum vibration peak-to-peak displacement of 2 mils. Provide mechanical or Teflon seal between shaft and housing. The shaft's first critical speed shall be at least 125% of the fan's maximum operating speed.

Shaft Bearings: Heavy duty, grease, lubricated, sealed, self-aligning, pillow block design, frictionless ball bearings having minimum life of 150,000 hours shall be used. Fan bearings shall be visible and accessible for inspection and maintenance. Bearings enclosed within the fan housing where they can be exposed to the corrosive gas stream are not acceptable.

Fan impeller and driving pulley shall be secured to shaft with keys and set screws. Fan housing shall have flanged discharge and inlet drilled connection and companion flanges. Fan shall be separated from ductwork at inlet and outlet by flexible connections. Fan inlet box shall have flanged inlet and outlet connections. The fan inlet box shall be coated with graphite impregnated resin in accordance with ASTM D 4167. Equipment slab shall be unitary base constructed of channel steel as required by the fan manufacturer. The fan and motor shall both mount to the structural steel frame. Fan mounting shall be AMCA Standard Arrangement 1. Fan base shall be bolted directly to the equipment slab and painted as specified in Master Specification Section 09900, Painting. The drive shall be of matched V-belts and adjustable sheave pulleys shall be cast steel. The belt and shaft guard shall be steel construction and galvanized then painted as specified in Master Specification Section 09900, Painting, with tachometer hole, OSHA approved. The access doors shall be raised type, bolted with gasket. Nuts, bolts and fasteners in contact with the gas stream shall by Type 316-stainless steel and encapsulated in FRP. Stainless steel nameplates giving the name of the manufacturer, serial number, model number, rated capacity in cfm, head in inches of water gage, fan rpm, and any other pertinent data shall be permanently affixed with stainless steel hardware to each fan.

Drains: Provide drains at low point of scroll, 1-inch pipe bonded to housing with threaded corrosion resistant plug.

Coatings: Ferrous metal fan part coatings shall as per Steel Structures Painting Council SSPC-SP 5-63 white metal blast cleaning. Ferrous metal fan part coating for baked epoxy phenolic or “cold set” epoxy-phenolic amine cured shall be brushed or sprayed coats as per manufacturer's specifications.

Fans: Fan assembly shall be tested and balanced in accordance with Master Specifications Section 15990, Testing, Adjusting and Balancing. The complete fan assembly shall be inter-radial dynamic machine (IRD) 245 balanced at design RPM with motor sheaves and belts in place to 1.0-mil displacement or less and shall be checked for vibration after installation by the fan manufacturer's personnel trained in such work. A complete report shall be furnished to Engineer. If the amplitude of any vibration exceeds 1.0 mils, the fan shall be dynamically balanced in place and retested.

Differential Pressure Gage/Switch: Provide a photohelic differential pressure gage/switch at the fan inlet and outlet, to measure the fan inlet pressure and the fan outlet pressure. Gage shall be the dial type with die cast aluminum, irridite dipped for corrosion resistance. The range for fan inlet shall be 10 in vacuum to 10 inches water gage and range for fan outlet shall be 0 to 12 inches water gage with accuracy of 2 percent of scale. Switches for high and low set point shall be adjustable from knobs on gage face.

Quantity	2 per unit
Type	DPDT, Rated 10 A @ 120 VAC
Power requirement	120 VAC
DeadBand	Maximum 1 percent of full scale
Enclosure	NEMA 4X

Manufacturer: Provide products of one of the following: Dwyer Instrument, Incorporated Model 3000 series Photohelic Pressure Switch/Gage, or approved equal.

2.3.03 Drive Units. Motors shall be provided with specified maximum horsepower at 1800 RPM constant speed. Motor information specified herein shall be coordinated with Master Specifications Section 16220, General Purpose Induction Motors. TEFC type with premium efficiency suitable for operation (480 volt, 3 phase, 60 Hz power, solid shaft, ball bearing type), mount Fan per manufacturer requirements for outdoor use, and shall be provided with a service factor of 1.15. Provide positive temperature thermistors and a solid state relay. The sealed thermistors shall be installed in the end turns of the stator winding, one per phase. Solid state relay shall detect and protect against open or shorted sensors. Relay shall be mounted in and powered from MCC (120 VAC). Relay shall provide dry contact interlock to shutdown motor on high temperature. Provide thermistors from one of the following manufacturers: Therma Sentry by U.S motors, Reliance Thermistor System by Reliance or approved equal. Provide 120 volt space heaters in motor windings to prevent condensation.

2.3.04 Controls. Odor Control Fan Operation: Furnish a local control panel for each fan, provided by the fan manufacturer, for mounting adjacent to each. Each odor control fan shall have two modes of operation, “Local” and “Remote”. Fan shall be placed in “Local” or “Remote” from local control panel. In the “Local” position a fan shall operate by the “start” and “stop” pushbuttons located on the local control panel.

In “Remote” position, a remote signal from the specified control system in the control building shall start and stop the fan.

Safeties/Interlocks: All safeties/interlocks shall be hard wired to the fan MCC starter. All alarm conditions shall be repeated individually at the local panel and at the specified control system. In the “Remote” position, if a fan fails to start when called an alarm shall be signaled. If a fan fails when running, an alarm will be signaled. Low suction pressure shall stop a fan and signal an alarm. High discharge pressure shall stop a fan and signal an alarm. The “Stop” pushbutton shall stop a fan in both “Local” and “Remote” mode of operation.

Local control panel: Local control panel shall be a NEMA 4X enclosure mounted on support framework adjacent to the fan. Panel shall be all Type 316 stainless steel construction with a minimum thickness of 12 gauge for all surfaces (except those areas requiring reinforcement) having a smooth brushed finished. Provide continuous stainless steel piano hinged door with stainless steel screws and clamps on three sides of door. Provide all internal devices mounted on 12 gauge steel sub panel with white enamel finish.

2.4 GREASE FILTERS/MIST ELIMINATOR.

2.4.01 Acceptable Manufacturer. Provide grease filter/mist eliminators as manufactured by one of the following: Calgon Carbon Corporation, U.S. Filters, Munters Corporation, or approved equal.

2.4.02 Construction. Service conditions shall include that at the design gas flow rate, the external demisters shall remove minimum of 99.9% of droplets between 5 microns and 10 microns, and pressure drop through the demisters shall not exceed 1.0 in w.c. at 25,000 cfm.

External demisters shall contain horizontal grease and mist eliminator constructed of PVC with FRP frames. Provide two nested modules suitable for operation at the design gas flow rated 25,000 cfm.

The grease filter/mist eliminator shall be enclosed in FRP housing. The housing shall be of hand lay-up construction with the same resins and reinforcements as specified for the odor control vessel. Minimum thickness of the housing shall be 0.5 inches. The FRP shall be pigmented beige.
The grease filter pad shall be 2 inches thick and constructed of 304L stainless steel.

The mist eliminator pad shall be 4 inches thick and constructed of woven polypropylene. Provide a side mounted module access cover.

Gas inlet and outlet connections shall be circular, flanged connections the same size as the connecting ductwork. Flanges shall be of hand lay-up construction in accordance with NBS PS 15-69 and shall be ANSI 16.5, 150 lb.

Provide a flanged, ¾ inch diameter drain connections at the bottom of the FRP housing.

Differential Pressure Gage/Switch: Provide a magnehelic differential pressure gages at each grease filter /mist eliminator to measure the differential pressure through the grease filter/mist eliminator. Gages shall be the dial type with die cast aluminum, irradiate dipped for corrosion resistance. The range shall be 0 to 15 inches water gage for the grease filter/mist eliminator, accuracy of 2 percent of scale. The accessories used shall be Two 1/8 inch NPT plugs, two 1/8-inch NPT pipe thread to rubber tubing adapters and three flush mounting adapters with screws, 50 linear feet of tygon plastic tubing, two static pressure tips, two plastic vent valves, with integral compression fittings on tips and valves. Mount gages as grease filter/mist eliminator on brackets provided by Contractor. Provide products of one of the following manufacturers: Dwyer Instrument Incorporated Model 2015 Magnehelic Gage, or approved equal.

2.5 FAN ACOUSTICAL ENCLOSURE.

2.5.01 Acceptable Manufacturers. Provide a Fan Enclosure Unit as Manufactured by on of the following: Niess, Industrial Acoustics Company, or approved equal.

2.5.02 Construction. Provide a double wall, insulated, acoustical enclosure for each fan-motor unit suitable for outdoor installation. The enclosure shall be complete with frame walls, roof, observations, windows and air intake and discharge silencers. All panels and components shall be prefabricated and shall not be susceptible to damage form extended to airflow, pressure differentials, vibration, air, temperature, or humidity. The entire enclosure shall be designed by the manufacturer to be self-supporting when any or all of the side panels are removed. The enclosure shall be independent of the fan and ductwork. Enclosure size is shown approximately on the drawings. Final size shall be determined by the Contractor and enclosure manufacturer to suit the face actually furnished.

Enclosure shall have three double-leaf access doors on both long side and one double-leaf access door on the inlet side arranged to permit access to all parts of the fan assembly for services and major maintenance.
All panels shall be not less than 6 inches thick with a solid steel exterior shell with a minimum 16-gauge thickness and a perforated, galvanized steel interior shell with a minimum 22-gauge thickness.

The outer framework shall be constructed of steel with a minimum 11-gauge thickness, and shall be painted a gloss black color.

Each panel assembly shall be completely filled with acoustical/thermal insulating material that is noncombustible, inert, mildew resistant, and vermin-proof. Insulations shall not settle within the panel assembly. No insulating materials shall be used that have a flame spreader greater that 25 or smoke developed greater than 50, as determined by ASTM Standard E 84 (UL-723, NFPA 255).

Each panel shall contain a 1/8 inch thick layer of mineral wool attached to the perforated interior surfaces for vibration damping. The mineral wool layer shall be completely wrapped in 2 mil. Polyethylene for protection.

A layer of 1 inch thick mineral wool shall be placed adjacent to the vibration damping layer. Insert a 2 pound per square foot Septum barrier between the mineral wool and second 1 inch thick layer of mineral wool. The paint color shall be approved by Engineer.

Provide an additional 4 inch thick layer of mineral wool into the fabricated, galvanized steel frame. The exterior color of the panels shall be painted with industrial enamel paint.

Acoustical Performance: The manufacturer shall provide certified testing data from an acoustical laboratory, listing sound absorption and transmission loss characteristics of the panel assembly. Testing data may be for galvanized panels. The Insertion Loss measured at a 1 meter distance form the enclosure and 2 meter above the ground shall be a minimum of 24 dBA. The test shall be performed in accordance with the OSHA measurement standards and the NMTBA (National Machining Tool Builders Association) standards.

Insulating materials used in all prefabricated panel assemblies shall have the following maximum thermal conductivities and nominal thermal resistance (r) at a mean temperature of 75F.
Thermal Conductivity (BTU/HR ft^2-°F) Nominal R Value
4-inch panel construction -.06 BTU/HR ft^2-°F

All perimeter and interior channel members and trim items shall be of steel, not less that 11 gauge. Furnish all anchor bolts, nuts, and washers which shall be Type 316 stainless steel. The enclosure unit shall be bolted directly to the equipment slab.

Where required for acoustical performance, base/channel/floor interface shall be sealed with a caulking sealant. Sufficient sealant shall be used to extrude surplus sealant and give a visual indication of complete coverage in all joints. The sealants shall have sufficient adhesive strength to prevent air leakage through the assembly when a pressure differential exists, but still allow system disassembly without damage to the panel components.

Provide one 18 inch by 24 inch observation window to visually observe the motor. Window shall be constructed of double pane ¼ inch thick safety glass held in place with neoprene acoustical seals and separated by an air space of the same thickness as the panel.

Provide an acoustical air intake silencer and acoustical discharge silencers with an integral fan curb in the enclosure wall so it will admit air for cooling the enclosure with minimizing sound exiting enclosure. The air intake and discharge silencers shall meet the following service conditions and the requirements of Master Specifications Section 01180, Equipment, Materials, Parts, and Tools. Number of Units shall be as specified, CFM shall be as specified, and total Static Pressure in each silencer shall be in w.c.: as specified, for acoustical performance, the insertion loss shall be at a minimum equal the performance of the enclosure walls. The fan of the fan motor may provide primary air movement and cooling inside the enclosure. An auxiliary exhaust fan shall be mounted on the acoustical enclosure to provide air circulation during fan operation.

Auxiliary exhaust fan motors: Service conditions shall include number of units as 1 per enclosure, CFM shall be as specified, and Total Static Pressure each silencer, in w.c.:as specified. Motor information specified herein shall be coordinated with Master Specification Section 16220, General Purpose Induction Motors. The requirements of this article supersede any conflicting requirements in Master Specification Section 16220, General Purpose Induction Motors. The electric motor shall be Dome Type suitable for operation on 480 volt, 3 phase, 60 Hz power, solid shaft, and with ball bearing.

Openings for pipe penetrations and conduits shall be field cut to ensure proper positioning. Provide framing members, collars and fittings as required insuring the openings are sealed against acoustical leakage.

PART 3 – EXECUTION

3.1 INSPECTION. Inspect and verify that structures or surfaces on which the equipment will be installed have no defects, which will adversely effect installation, inspect all equipment prior to installation, and promptly report defects, which may affect Work to the Engineer.

3.2 INSTALLATION. Install equipment in accordance with the Drawings, approved Shop Drawings, the manufacturer's instructions and the supplemental requirements. Connect all piping and instruments as required. Support all piping independent of odor control vessel. Align, adjust, and lubricate equipment in accordance with the manufacturer's instructions, and leave in proper working condition. Provide minimum of one inch of non-shrink grout below all floor stands. Touch up minor scratches and scrapes in painted finishes as specified in Master Specification Section 09900, Painting.

3.2.01 Protection. Field and shop painting shall be provided in accordance with Master Specification Section, 09900, Painting. Paint FRP surfaces of ductwork and grease filter/mist eliminator FRP housing. Prepare FRP surfaces by hand sanding FRP surfaces to be coated with a medium grit sand paper prior to painting. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughed without removing excess material. Painting shall be provided in accordance with Master Specification Section 09900, Painting.

3.3 FIELD QUALITY CONTROL.

3.3.01 Field Test. After Contractor and Engineer have mutually agreed that the equipment installation is complete and ready for continuous operation, Contractor and a qualified field service representative of the manufacturer shall conduct a running test of the odor control system in the presence of Engineer to demonstrate that the mechanism and its controls will function correctly. Make adjustments required to place equipment in proper operating condition. During initial operation and in the presence of manufacturer's representative the Contractor shall set dampers to balance the airflow through the vessel.

3.3.02 Inspection. A manufacturer's factory trained representative shall check and approve the installation before operation. The representative shall operate and test system in the presence of Engineer and verify that the equipment conforms to requirements, and instruct plant personnel on care and maintenance. The representative shall revisit the job site as often as necessary until all deficiencies are corrected. Perform testing, checkout and start-up of the equipment under the technical direction of the manufacturer's factory-trained representative. Do not energize motor operators without authorization from manufacturer's representative. Conduct a leakage test on each odor control vessel by providing a suitable area on site, but not on the basin cover to perform a hydrostatic test on each vessel by:

Filling each vessel to a height of 12' of water.

Allowing to standing for 2 hours to verify no leakage.

Vessel shall be inspected for leakage by manufacturer's representative.

Provide a written report in accordance with Section 1.4

If leakage is determined manufacturer shall submit a corrective action plan for the repair or replacement of the vessel. No corrective action shall be taken without Owner's approval.

If the vessel fails a second hydrostatic test, it shall be replaced.

Contractor shall install the odor control vessel within 24 hours of passing the hydrostatic test.

3.4 TRAINING. Furnish services of a qualified factory trained operations and maintenance serviceman to instruct and train operators in the proper care, operation and maintenance of the equipment. Provide these services for the time period of a minimum of 30 days and in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

3.5 MAINTENANCE. Provide services of factory trained representative of the manufacturer to correct defective work during the one year correction period. Replacement parts of equipment installed during the one-year correction period shall be equal to or better than the original.

End of Section

SECTION 15891

DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE. Furnish, fabricate and install all ductwork, including fittings, accessories, dampers, duct liner, hangers, diffusers, registers, grilles and any incidental work or components required to provide complete air supply, return and exhaust ductwork systems as shown on the Drawings and as specified herein.

In general, ductwork shall consist of any passageway made of sheet metal or other material substantially air-tight, used for the conveying of air, gas or materials. Included are fittings, transitions, bracing, fasteners, sealers, supports and accessories such as access panels, access doors, turning vanes and manual air balancing dampers. All ductwork shall be of size and material as specified herein and as shown on the Drawings. All duct sizes indicated on the Drawings are clear, inside dimensions. Where ductwork is lined with fiberglass, duct sizes shown on the Drawings are clear, inside dimensions to the duct liner material.

Any change in duct sizes, offsets, transitions and fittings required to accommodate job conditions shall be submitted to the Engineer for approval.

All ductwork and equipment shown on the drawings is intended to be approximately correct to scale, but figured dimensions and detailed drawings of the actual equipment furnished shall be followed in every case. The drawings shall be taken in a sense as diagrammatic. Size of ductwork and piping are shown, but it is not the intent to show every offset or fitting, nor every hanger or support, or structural difficulty that may be encountered. To carry out the intent and purpose of the drawings all necessary parts to make a complete working system ready for use shall be furnished without extra charge. The contractor shall be responsible to coordinate the system installation and routing with the work of all trades.

1.2 RELATED REQUIREMENTS. Cutting and patching is included in Division 2 except for items specified herein. Concrete work is included in Division 3 except for required HVAC anchor bolts, sleeves and templates, which shall be furnished under this Section.

Structural steel and miscellaneous metal is included in Division 5 except for supplementary steel required for HVAC hangers, equipment supports, anchors and guides, which shall be furnished under this Section.

Flashing and counter flashing is included in Division 7 except for items specified herein.

Painting is included in Division 9 except for factory finished HVAC equipment, HVAC shop painting and HVAC identification labeling and as required in Paragraph 3.15 below.

Exterior louvers and louver blank-off panels are included in this Section.

Thermal Insulation is included in Section 15290. This Section specifies the insulation type and thickness for the systems specified herein.

Electric duct heaters are specified in Section 15550 and installed under this Section.

Control dampers and duct mounted instruments are specified in Section 15950 and installed under this Section.

For fiberglass ductwork refer to Section 15895.

1.3 SUBMITTALS. Submit, in accordance with Section 01300, the following Drawings and data. Detailed equipment and ductwork drawings at a minimum scale of 1/8-in =1-ft-0-in. Drawings shall locate ductwork accessories including manual, automatic and fire dampers. Ratings of fire dampers shall be shown. Drawings shall also show and dimension maintenance clear spaces for motors, drives, coils, filters and access doors or panels. Indicate ductwork pressure class used for fabrication.

Standard shop and field installation details for transitions, elbows, takeoffs, discharge nozzles, turning vanes, access panels and doors, volume control and splitter dampers, hangers and volume extractors. When SMACNA references are used, the specific methods for the project shall be clearly defined. Where SMACNA has more than one option, the option to be used shall be indicated.

Ductwork materials, joining methods, reinforcing and material gauges. Where options are allowed by SMACNA, the proposed option shall be clearly defined. Indicate proposed materials and methods for ductwork and equipment hangers.

For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit.

All submittals shall contain a statement that Sections 15500, and all other Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4 REFERENCE STANDARDS. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. The Engineer shall resolve conflicts between published requirements.

Titles and abbreviations of Federal, State and industry standards, technical societies, associations and institutes and other organizations which may be used are as follows:

American Conference of Governmental Industrial Hygienists (ACGIH)

Air Movement and Control Association (AMCA)

American National Standards Institute (ANSI)

Air-conditioning and Refrigeration Institute (ARI)

Air Diffusion Council (ADC)

ADC 1062-R4 - Certification, Rating and Testing Manual.

American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE)

ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

American Society of Mechanical Engineers (ASME)

American Society for Testing and Materials (ASTM)

ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron, Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

Factory Mutual (FM)

National Institute of Standards and Technology (NBS)

National Fire Protection Association (NFPA)

NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.

NFPA 102 - Standard for Grandstand, Folding and Telescopic Seating, Tents and Membrane Structures.

NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

Occupational Safety and Health Administration (OSHA)

Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

Underwriters Laboratories (UL)

UL 181 - UL Standard for Safety Tests for Flame-Propagation of Fabrics and Films.

UL 555 - UL Standard for Safety Fire Dampers.

UL 723 - UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE. Inspection by the Engineer’s representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents. The Owner and Engineer reserve the right to check and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

1.6 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer. All materials shall be stored in a covered dry location off of the ground.

1.7 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts and shall meet the requirements of Sections 01750 and 01760. In addition to special items, the following spare parts shall be provided:

Furnish all special tools required for normal operation and proper servicing of the equipment.

Provide a minimum of 1 or 5 percent of the total units rounded to the next full unit whichever is greater for each size and rating of the following components.

Fire damper fusible links

Thermostats

Thermometers

Pressure gages

Control relays

Damper operators

Control transmitters

Control transformers

Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers.

1.8 DEFINITIONS. Particular terminology used under this Section is defined as follows: Traffic Level and Personnel Level - Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends vertically to 8-ft above floor, walkways, platforms and stairs, and horizontally 3-ft beyond the edge of walkways, platforms, and stairs.

Exposed Piping and Ductwork - Piping and ductwork visible from the floor level and includes all piping and ductwork in equipment rooms, boiler rooms, etc.

Concealed Piping and Ductwork - Piping and ductwork not visible from the floor level and includes piping and ductwork above hung ceilings and in shaftways.

Supply Air Ductwork - Ductwork carrying air from a fan or air handling unit to the space or spaces to which it will be introduced. This air may have been heated or cooled or in the case of ventilation system the air would be neither heated nor cooled. Supply air ductwork extends from the fan or air handling unit to the registers, grills or diffusers at the end of the ductwork.

Return Air Ductwork - Ductwork carrying air from the space it was supplied to back to a fan or air handling unit. Return air ductwork extends from the registers or grills at the end of the ductwork to the air handling unit or connection with an outdoor air intake duct.

Exhaust Air Ductwork - Ductwork carrying air from a space to a fan and then to be discharged to the outdoors. Exhaust air ductwork extends from the registers or grills at the end of the ductwork to the fan. From the fan the exhaust ductwork extends to the discharge point, exhaust air damper, or exhaust air plenum, whichever comes first.

Relief Air Ductwork - Ductwork carrying air from a space without a fan to be discharged to the outdoors. Relief air ductwork extends from the registers or grills at the end of the ductwork, the discharge point, relief air damper, or relief air plenum, whichever comes first.

Outdoor Air Ductwork - Ductwork carrying untreated air from the outside to a fan or air handling unit. Outdoor air ductwork starts at the intake point, outdoor air damper, or outdoor air plenum, whichever comes last. The outdoor air ductwork extends to the fan, air handling unit, or connection with a return air duct, whichever comes first.

Mixed Air Ductwork - Ductwork that can carry either return air or outdoor air or a combination of both. Mixed air ductwork starts at the connection of the return air and outdoor air ducts and extends to the fan or air handling unit.

Outdoor Air Plenum - A plenum that extends from the opening in the skin of the structure to the outdoor air duct. If the outdoor air damper is directly at the intake or there is no outdoor air damper, the plenum will extend to the first size reduction. If the outdoor air damper is not at the intake, the plenum will extend to the outdoor air damper.

Exhaust Air Plenum - A plenum that extends from the opening in the skin of the structure to the exhaust air duct. If the exhaust air damper is directly at the discharge or there is no exhaust air damper, the plenum will extend from the last size reduction. If the exhaust air damper is not at the discharge, the plenum will extend to the exhaust air damper.

Relief Air Plenum - A plenum that extends from the opening in the skin of the structure to the relief air duct. If the relief air damper is directly at the discharge or there is no relief air damper, the plenum will extend from the last size reduction. If the relief air damper is not at the discharge, the plenum will extend to the relief air damper.

Ventilated Spaces - Areas supplied with outdoor air on a continuous or intermittent basis. The outdoor air may be heated and/or cooled or untreated.

Heated Spaces - Areas where heat is supplied to maintain a minimum temperature during the heating season.

Unheated Spaces - Areas where heat is not applied and there is no minimum temperature during the heating season.

Conditioned Spaces - Areas that are provided with heating and mechanical cooling.

Non-Conditioned Spaces - Areas that are not provided with mechanical cooling.

Thermal Conductivity - The rate of heat flow through unit area of a homogeneous substance under the influence of unit temperature gradient in the direction perpendicular to the area. Units-BTU per (hour)(sq ft)(degrees F temperature difference)(per inch thickness).

Indoor Ductwork - Ductwork within a building that is not exposed to the weather.

Outdoor Ductwork - Ductwork that is not within a building and is exposed to the weather.

Hot Ductwork - Ductwork carrying air with a temperature above the surrounding space temperature.

Cold Ductwork - Ductwork carrying air with a temperature below the surrounding space temperature.

Hot/Cold Ductwork - Ductwork carrying air with a temperature that can be either above or below the surrounding space temperature.

Flues/Stacks/Breeching - Ductwork carrying products of combustion to atmosphere.

1.9 COORDINATION. The Drawings indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary, details of such departures and the reasons therefore shall be submitted as soon as practical for review. No such departures shall be made without the prior written concurrence of the Engineer.

The Contractor shall coordinate the location and placement of all concrete inserts and welding attachments with the structural engineer.

The Contractor shall assume full responsibility for coordination of the HVAC systems, including; scheduling, and verification that all structures, ducts, piping and the mounting of equipment are compatible.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION FOR DUCTWORK. Flexible connections for conventional air conditioning systems shall be glass fabric coated with polychloroprene. Fabric must comply with Underwriters Laboratories Standard UL214 and NFPA Bulletin 90A. Connections shall be Ventglas by Ventfabrics or equal.

Flexible connections for process exhaust systems shall be fiberglass fabric coated with Duponts teflon. Fabric must be resistant to Sodium Hypochlorate. Fabric must comply with Underwriters Laboratories Standard UL181 and NFPA Bulletin 102. Connections shall be Ventel by Vent Fabric or equal.

Furnish flexible connectors at each inlet and outlet of fan and in the duct runs where required for expansion, contraction and movement, and where called for on the Drawings. Flexible connections shall be integrally flange molded arch type units constructed of EPDM rubber 1/4-in thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service. The flexible connections shall be designed to minimize the transmission of vibration from the fans to the ductwork at the suction and discharge connections. Expansion or contractor flexible connections shall be designed to allow 1-in movement. Working length or “live” length shall be as designed by the manufacturer to allow up to 1-in of movement.

Ends shall be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints shall be molded and free of patches or splices. The flexible connections shall be suitable for outdoor service and temperature ranges from minus 10 up to 125 degrees F, and pressure to 5 psig. Specially fabricated split Type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanged with Type 316 stainless steel bolts are tightened. Acceptable Manufacturer: Holz Rubber Company, Mercer Rubber, Company, Proco Products Incorporated, or approved equal.

2.2 FLAME AND SMOKE RATINGS. All materials, including adhesives, surface coatings, sealers, assemblies of several materials, insulation, jacketing, finish, etc, shall have flame spread ratings not over 25 (fire resistive) and smoke development ratings not over 50 and fuel contributed rating not over 50, as established by tests conducted in accordance with the Federal Standard 00136B, National Bureau of Standards Radiant Energy Fire Test and the National Fire Code of the NFPA. These requirements apply to all circumstances whether the materials are field applied or applied by a manufacturer in his/her shop, or elsewhere, prior to delivery to the project.

2.3 SOUND CONTROL. The selection of ductwork and accessories shall be such as not to create noise that will exceed the levels of permissible noise exposures for occupational areas as established by the OSHA and other Federal, State and local safety and health standards, codes and ordinances. Acoustical Lining - Internal sound attenuation and insulation (for air conditioning ductwork) shall be 1-in thick bonded fiberglass mat coated with black pigmented fire resistive coating on the air stream side. Liner shall comply with NFPA 90A requirements. Flame spread and smoke development ratings shall be 25 and 50 respectively. Material shall be Owens Corning; Aeroflex or equal.

2.4 HANGERS, SUPPORTS AND ANCHORS. Furnish supports, hangers and other devices necessary to support firmly and substantially the equipment and ductwork described in this Section. Ductwork support systems shall include restrains as required by the applicable building codes to withstand seismic loading. All equipment, ductwork, and supports that are installed outdoors shall be designed and installed to meet wind loadings as required by the International Building Code, all other applicable codes, and the requirements specified herein. Design shall be provided by a professional engineer hired by the Contractor as specified in other sections of the specification. Signed and sealed calculations shall be submitted for record purposes.

Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as called for in the SMACNA standards, except as limited below.

Rectangular ductwork 48-in wide and larger shall be supported by adjustable threaded rod hangers.

Round ductwork 37-in and larger shall be supported by two adjustable threaded rods at each support.

All hangers shall be of same material as ductwork which they serve, e.g., galvanized, aluminum, black steel, etc, except for PVC ductwork which shall be Type 304 stainless steel.

All hanger hardware and fasteners shall be of the same material as the duct they serve or shall be of a material with equal or greater corrosion resistance. Where materials other than the duct material are used, they must be approved by the Engineer before installation.

Perforated band iron or wire for supporting ducts shall not be permitted.

Where C-clamp type hangers are used, furnish with a retainer strap.

Support flexible duct withType 304 stainless steel band hangers, 1-in wide minimum, attached so as not to crush the ductwork. The use of wire to hang flexible ductwork shall not be permitted.

The following methods of hanger attachment to the building structure are NOT allowed. The numbers and letters refer to hanger methods shown in Figure 4-1, 4-2 and 4-3 of the 1985 edition of the HVAC Duct Construction Standards Metal and Flexable as published by SMACNA.

"T"- wrap around strap on open web joist.

"W" - bent over band on open web joist.

"14" - friction clamps.

"17" - bent wire in metal deck.

Design of hangers shall include the effect of all loads applied to the duct as well as the load of the duct. These loads include, but are not limited to wind, snow and internal dirt or liquid buildup.

Hangers shall not be supported from roof decking or bulb tees. Where required, provide supplemental steel to span between the building structures.

2.5 DUCTWORK MATERIAL. Ductwork shall be constructed of the materials specified using the gauges or thicknesses, reinforcing and construction methods in accordance with SMACNA standards. Unless otherwise specified, all components of the duct systems shall be constructed of the same material as the ductwork. This is to include braces and turning vanes.

Galvanized steel ductwork shall be constructed of hot-dip galvanized sheet steel, per ASTM A653.

Stainless steel ductwork shall be constructed of Type 316 stainless steel. Aluminum ductwork.

2.6 DUCTWORK CONSTRUCTION DETERMINANTS. Low pressure ductwork shall be constructed of the following materials and to the SMACNA standards:

The following is to be used as a general guide for duct material select.

> Galvanized Steel – shall be used for normal heating, cooling, and ventilation applications where the air handled in surrounding the duct is relatively dry, and there are no corrosives.
>
> Stainless Steel – shall be used in areas that galvanized steel and aluminum are not suitable and as shown on the drawing.
>
> Aluminum – shall be used in areas where shown on drawing.

Design of ductwork shall include all loads applied to the ductwork, in addition to the load of the duct. These loads include but are not limited to wind, snow and internal dirt or liquid build up.

2.7 DUCTWORK CONSTRUCTION. All ductwork shall be substantially built with joints and seams smooth on the inside and given a neat appearance on the outside. Inside surfaces and joints shall be smooth and free from pockets, burrs and projections. All joints shall be substantially airtight with laps made in the direction of air flow and no flanges projecting into the air stream.

2.7.01 Pressure Classes. Pressure classes for determination of sheet metal gauge and reinforcing shall be as defined by the latest issue of the SMACNA - Industrial Duct Construction Standards. For systems with fans with a shut off static pressure higher than 2-in w.g., design pressure shall be as listed in Paragraph 2.06 above. For systems with fans a shut off static pressure 2-in w.g. or less design pressure shall be equal to the maximum pressure indicated for the fans or air handling units on the Schedules and the pressure class shall be the same for the entire length, including branches, of the specific duct system.

2.7.02 Rectangular Ductwork (Sheet Metal). Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA - Construction Standard. Cross-breaking shall conform to SMACNA standard. Cross-breaking shall be applied to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure rigidity for each panel.

Alternate Construction - Factory fabricated joint systems may be offered as an alternate form of construction. The system offered shall meet all requirements of

SMACNA. Alternate joint systems shall be "Ductmate System" as manufactured by Ductmate Industries, Inc., installed in accordance with the manufacturer's recommendations. The system shall be sealed for zero leakage and angle attachment to the main duct section shall be by tack welding. The use of screws is not allowed.

2.7.03 Round Ductwork (Sheet Metal). Ductwork shall be constructed as shown on the Drawings in accordance with the specified SMACNA - Construction Standard.

Round ductwork longitudinal seams shall be either lock type or continuous welded construction. Slip joints shall be used on ductwork and fittings up to 36-in in diameter and Vanstone flanges shall be used on ducts over 36-in in diameter.

Fittings shall be fabricated with continuous welds. 90 degree elbows shall have a turning radius of 1.5 times the fitting diameter. 90 degree elbows shall be mitered construction with five segments. All fittings in the round duct system shall be of the male and female type. Mechanically fasten the conduits together using sheet metal screws not less than four per fitting 6-in on centers maximum and equally spaced around the circumference of fitting.

Round ductwork and fittings shall be manufactured by United Sheet Metal; SEMCO or equal.

2.7.04 Insulated Round Flexible Ducts. Round flexible ducts shall comply with specified SMACNA - Construction Standards and be constructed of corrugated ductile aluminum that can be bent and rebent by hand and is self-supporting. 1-in insulation shall be applied around the outside and be finished with a vinyl cover.

Thermal conductivity of the insulation shall not exceed 0.27 BTU/hr/sq ft/1 degree F at75 degree mean temperature. Duct shall be Class I, per UL 181.

Maximum length shall be 5-ft. The remainder shall be galvanized sheet metal. Duct run shall be as short and straight as possible to minimize static resistance.

Ducts shall be Bendway as manufactured by Flexaust Company or approved equal.

2.8 VOLUME AND SHUT OFF DAMPERS. Rectangular dampers shall be multiple blade type with channel frame, exterior linkage and position indicator and locking device. Blades shall not exceed 6-in in width.

Round or oval dampers and splitters shall be shop fabricated, single blade type with position indicators and locking device. For galvanized sheet metal systems, material shall be two gauges heavier than ductwork or 18 gauge, whichever is heavier.

Dampers shall be constructed of the same material as the ductwork.

Shut off dampers shall have replaceable neoprene seals. Leakage rates shall not exceed 7 cfm/sq ft at 4-in w.g. for rectangular dampers and 0.15 cfm/in of perimeter at 4-in w.g. for round or oval dampers.

Dampers shall be supplied with locking quadrants. Quadrants in galvanized steel and black steel ductwork shall be galvanized steel. All other duct systems shall have stainless steel locking quadrants. Locking quadrants shall have a positive method of holding the damper in its selected position such as a bolt through both the quadrant and the lever arm. Systems using springs or other devices that can vibrate loose are not acceptable.

All dampers shall be flanged connections unless otherwise noted.

All dampers shall be selected for a rating that equals or exceeds the specified system pressure and velocity. Manufacturer shall be Ruskin or equal.

Balancing and balancing/shut off dampers shall be opposed blade. Shut off dampers shall be parallel blade.

2.9 ACCESS DOORS. Access doors shall be minimum 24-in by 24-in in ducts 26-in and larger. Where the duct size is less than 26-in, the largest door that can be accommodated shall be used. Access doors shall be of the same material as the duct, pan type construction for metal ductwork, with smooth edges and fitted seals, constructed and installed for air-tight fit with ease of opening and closing. Doors shall be substantially butt hinged, with heavy sash locks and substantial door pulls. Door openings and door frames shall be reinforced with bar stock or angle. Where ductwork is installed with duct liner or exterior duct insulation, the access door shall be of the insulated type. Access doors shall be factory fabricated. Where ductwork is constructed of aluminum or stainless steel, access door and hardware shall be of similar material.

Hand hole access panels shall be 12-in by 12-in, constructed of the same material as the ductwork, with peripheral gaskets and sash locks. Provide hinges or chain for attachment to duct.

2.10 FASTENERS. Sheet metal screws, drive cleats, cinch bands and other fasteners shall be fabricated from materials with an equal or greater corrosion resistance than the ductwork in which they are installed. Where a material other than the duct material is used, it shall be approved by the Engineer before installation

2.11 RELIEF DAMPERS. Relief dampers shall be manually operated or automatic gravity-type used for exhaust of air. Dampers shall be constructed of the same material as the ductwork with flanged connection and blades set in parallel-bladed position and gang operated by exterior linkage. Dampers shall have a shop coat of primer or aluminum finish as specified. Relief dampers shall be of size, type and capacity as specified on the Drawings. Adjustable counter-balanced gravity dampers shall be provided where indicated on the Drawings. Manufacturer shall be Ruskin or equal.

2.12 LABELS. The service of each duct along with and arrow indicating direction of flow shall be provided on each duct system. Labels shall be located not more than 26 linear feet apart and shall also be provided at both sides of wall penetrations, at each damper, and each equipment connection.

Labels shall contain the service spelled out, the duct size, and the equipment number of the equipment served. Label locations shall have unobstructed view from normal viewing locations.

Numbers and letters shall be die-cut from 3.5 mil vinyl film and pre-spaced on carrier film. Adhesive and finish shall be protected with one piece removable liners. Colors shall be white letters on black backgrounds.

The system for preparation and application of letters shall be Type B a.s.i./2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Letters shall be 3-in high Optima Bold, upper case using Grid 2 spacing. Direction arrows are to match. The instructions of the manufacturer shall be followed in respect to storage, surface preparation and application of letters.

Each piece of equipment is to be provided with an identification label listing the unit number and the areas served. Labels shall be as specified above.

2.13 DIFFUSERS, REGISTERS AND GRILLES. All diffusers, registers and grilles shall be of the shape, sizes, capacity and type as shown on the Drawings. On all duct openings that do not have a specific diffuser, register, grill or mesh cover provide a wire mesh cover.

Finish - Unless otherwise specified, diffusers, registers and grilles shall have the following finish. All diffusers, registers and grilles located in ceilings shall have a baked white enamel finish except where the ceiling system has an exposed aluminum support grid. Where the ceiling has an exposed aluminum support grid the diffusers, registers and grilles shall have a baked aluminum enamel finish. All diffusers, registers and grilles not located in ceilings shall have baked aluminum enamel finish.

2.13.01 Supply Air Diffusers. General - Diffusers shall be a factory-assembled unit of welded steel construction consisting of a housing with built-in louvers, cones, vanes or other means of directing discharge of air in a particular pattern principally for overhead or ceiling air diffusion. All diffusers shall be equipped with a volume control device. Distribution of air may be adjustable if so specified.

2.13.02 Exposed Duct Mounted Diffusers. Diffusers shall be of the adjustable type for ease of horizontal and vertical adjustment of air pattern. Refer to Drawings for direction of air throw. Each diffuser shall be equipped with an equalizing grid, baffles as required and extended bottom plate flange designed specifically for air diffusion from diffusers mounted on exposed ductwork. Acceptable manufacturers shall be Titus, Krueger and Price.

2.13.03 Supply Air Grilles. In general, grilles shall be a factory-assembled unit consisting of a grille with double deflecting adjustable airfoil vanes to diffuse supply air in the various directional patterns as shown on the Drawings. Grilles shall be of aluminum frame and border with aluminum louver blades. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Front and rear louver blades shall be individually adjustable. Where wall mounted, front blades shall be vertical and rear blades shall be horizontal. Where ceiling mounted, front blades shall be parallel to long dimension. Grilles shall be Series 272F by Titus Manufacturing Corp.; Krueger and Price.

2.13.04 Supply Air Registers. Registers shall be a factory-assembled unit consisting of a grille with adjustable vanes to diffuse supply air in the various directional patterns as shown on the Drawings and a damper. Grilles shall be of aluminum frame and border with aluminum louver blades. All registers shall be furnished with a sponge rubber gasket to prevent streaking. Supply air registers shall have aluminum opposed-blade dampers. Front and rear louver blades shall be individually adjustable. Where wall mounted, front blades shall be vertical and rear blades shall be horizontal. Where ceiling mounted, front blades shall be parallel to the long dimension.

2.13.05 Exhaust Air Grilles / Registers. Acceptable manufacturer shall be Titus Manufacturing Corp.; Krueger and Price

2.13.06 Return Air Grilles / Registers. Louver-Faced Return Air Grilles. In general, grilles shall be a factory-fabricated unit of aluminum frame border and louver blades. All grilles shall be furnished with a sponge rubber gasket to prevent streaking. Acceptable manufacturer shall be by Titus Manufacturing Corp.; Krueger and Price.

2.13.07 Eggcrate Type Return Air Grilles. Return air grilles shall be of all aluminum construction consisting of 1/2-in thick cores with 1/2-in square grid size. The square grid pattern shall provide maximum free area with minimum "see through." Acceptable Manufacturers shall be: Titus Manufacturing Corp., Price, Krueger Manufacturing Co., Inc., or approved equal.

2.13.08 Wire Mesh Covers. Where wire mesh covers are called for on the Drawings, the wire mesh and support frame shall be the same material as the duct where the cover is installed. Unless otherwise noted the wire mesh shall be 0.5-in mesh. The wire mesh shall be contained in a metal frame. The mesh shall be firmly attached to the frame to prevent it being pulled out of the frame by casual contact. The frame shall be a minimum of 16 gauge sheet metal or the minimum gauge for a flange based on SMACNA, whichever is greater. The frame shall be on both sides of the mesh creating a sandwich with the mesh in the middle. Fastenings shall go through the frame on both sides of the cover.

2.14 ROOF CURBS. Roof curbs shall be furnished for all roof mounted HVAC equipment including fans and relief or intake vents. Roof curbs shall be pre-fabricated type, minimum 12-in height and sized to match the dimensions of the equipment base supported. Roof curbs for fans are specified under Section 15860. Curbs shall be straight sided type of all aluminum welded construction with nominal 2-in thick acoustical/thermal insulation in curb walls. A perforated metal liner shall be provided to protect the insulation. Curbs shall provide a flat top surface regardless of the roof slope. Curb interiors shall be provided with protective coatings when a coating is specified.

2.15 TURNING VANES. Turning vanes shall be shop fabricated and installed in all abrupt rectangular elbows. Single thickness or airfoil type double thickness blades shall be chosen based on SMACNA recommendations.

Vanes shall be fabricated from the same material as the ductwork and manufactured by Elgen; Duro-Dyne; Aero/Dyne or equal.

2.16 VOLUME EXTRACTORS. Volume extractors shall be shop fabricated with synchronized curved extractor blades, heavy side rails and screw operator.

Extractors shall be fabricated from the same material as the ductwork and manufactured by Carnes; Titus or equal.

2.17 FIRE DAMPERS. Fire dampers shall meet local codes and the requirements of the NFPA Pamphlet No. 90A. Dampers in systems constructed of materials other than galvanized steel shall be constructed of Type 316 stainless steel.

Dampers shall be sized so that the free air space is not less than the connected duct free area. Location shall be as shown on the Drawings and required by code. Dampers shall have a minimum 1-1/2 hour standard fire protection rating in accordance with NFPA Pamphlet No. 252 and UL 555. Where the fire protection rating of the partition exceeds 2 hours, multiple dampers in series may be used to provide a rating equal to the partition.

Fusible Links - Dampers shall be arranged to close automatically and remain tightly closed upon the operation of a UL approved fusible link or other approved heat actuated device, located where readily affected by an abnormal rise of temperature in the duct. Fusible links shall have a temperature rating of 50 degrees F above the maximum normal duct operating temperature, but not less than 165 degrees F.

Workmanship - Install dampers in sleeve unless noted otherwise on the Drawings or in the case of dampers listed for installation without sleeves after specific approval from the Engineer. Fire dampers shall be installed to provide a positive barrier to passage of air when in a closed position. Dampers shall be installed so they will be self-supporting in case of duct destruction due to heat. Care shall be exercised that the frame be set so that the closing device will not bind.

Factory fabricated, steel-curtain type, UL approved fire dampers, with damper blades out of the air stream, are acceptable. These fire dampers shall be installed in accordance with the manufacturer's instructions and UL 555.

Access Doors - Tight fitting access doors shall be provided for accessibility to dampers and fusible links for inspection and maintenance.

All fire dampers shall have written approval from local authorities.

PART 3 - EXECUTION

3.1 <u>INSTALLATION OF DUCTWORK</u>. Fabricate and erect all ductwork where shown on the Drawings, as specified herein, and in accordance with SMACNA standards. Rigidly support and secure ductwork.

The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

Wherever ducts are divided, maintain the cross-sectional area. All such changes must be approved and installed as directed by the Engineer or as approved on shop or erection drawings.

During installation, temporarily close the open ends of ducts to prevent debris and dirt from entering. Install work in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.

Install louver blank off panels provided by the louver manufacturer as specified under Section 10200. Provide louver manufacturer the louver blank off panel dimension requirements. Secure blank off panels to the building structure using aluminum angles and rustproof fasteners. Caulk perimeter completely to eliminate water penetration.

Cross-break sheet metal in accordance with SMACNA duct construction standard. Apply cross-breaking to the sheet metal between the standing seams or reinforcing angles. The center of the cross-break shall be of the required height to assure each panel section being rigid.

Cross-break streamlined ducts on top only and adequately brace internally.

Beading as specified in SMACNA will be acceptable in lieu of cross-breaking.

The Drawings of the air ducts and air risers show the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes must be considered in the original bid and shall be installed at no additional cost to the Owner.

All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required. Wherever this is necessary, maintain the cross-sectional area. All of these changes, however, must be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.

The taper of all transformations shall be not more than 15 degrees.

Secure casing to curbs according to SMACNA "Duct Construction Standards."

Provide baffle plates as required to prevent stratification and to provide proper operation of controls.

Where ducts are constructed of materials other than galvanized steel the reinforcing members shall be of the same material as the ductwork.

The use of button punching or snap locks on ductwork constructed of aluminum shall not be permitted.

Ducts carrying moist air that pass through areas that could cause condensation shall be pitched to facilitate condensate removal. Low points of such ducts shall be provided with drains.

Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self-tapping screws or other fastening methods that will damage the coating are not acceptable.

3.2 HANGERS. Rectangular, Round and Flat-Oval Ductwork - Spacing and size of hangers shall be as recommended in the SMACNA standards except as noted in PART 2.

Install hangers plumb and securely suspended from supplementary steel or inserts in concrete slabs. Sufficiently thread lower ends of hanger rods to allow adequate vertical adjustment. Do not use building siding or metal decking to hang ductwork.

Ducts shall not be supported from furring, hung ceilings or from another duct or pipe.

C-clamp type hangers shall be supplied with a retainer strap.

Ductwork shall not come in contact with any of the ceiling construction or any other equipment in the ceiling cavity.

Duct support at flexible connections shall be adjustable for ease of aligning the duct to the piece of equipment.

3.3 SEALING OF DUCTWORK. General - Unless otherwise indicated, seal all ductwork joints and seams using sealant in accordance with the instructions of the sealant manufacturer and this Section. All transverse seams, joints and fitting connections, both shop and field assembled, shall be sealed in accordance with this Section. Longitudinal seams shall be sealed on all duct systems with a design operating pressure greater than 2-in w.g.

Application of Sealant - Thoroughly clean all seams, joints, etc, of dirt, oil, grease, or other coatings which might interfere with the adhesion of the duct sealant before the sealant is applied.

Uncured sealant may be forced into the slotted side of the seam or joint before shop or field assembly and the joint or seam completed while the sealant is still uncured. Excess sealant shall be removed from both the inside and outside of the duct before it sets.

Duct Tape - The use of duct tape alone for sealing ductwork is prohibited. Duct tape may be used primarily for the purpose of retaining the uncured duct sealant in seams and joints until it has cured. Duct tape shall not be applied to the inside of any duct nor shall it be applied to standing type joints at any time. All duct tape used shall be compatible with the sealant. The use of sealant saturated tape is acceptable when part of an integrated sealing system.

Sealant shall be either in liquid form or a mastic with a maximum flame spread of 25 and a maximum rate of fuel contributed and smoke developed of 50 when tested in accordance with ASTM E84, NFPA 255 and UL 723.

Sealing systems shall be suitable for the environment. The following schedule is to be used to select the sealant.

Indoor, dry galvanized round and rectangular duct is to be sealed with Iron Grip 601 or equal.

Indoor, dry, stainless steel, aluminum and PVC coated is to be sealed with FTA 20 adhesive and DT-Tape gypsum or equal.

All other areas unless otherwise noted are to be sealed with FTA 50 adhesive and DT- Tape gypsum or equal.

All sealers listed are manufactured by Hardcast Inc and are to define the type of sealer. Other equal sealants are acceptable.

3.4 DUCTWORK FITTINGS AND ACCESSORY ITEMS. Duct Elbows - Changes in direction and offsets shall be made in a gradual manner to facilitate streamline flow of air. All elbows shall have a centerline radius of not less than 1-1/2 times the width of the duct in the plane of the elbow. For rectangular ductwork where full radius elbows cannot be installed, provide abrupt elbows equipped with shop-installed turning vanes unless noted otherwise on the Drawings.

3.4.01 Flexible Fabric Connectors. Install flexible connectors for vibration isolation at all duct connections to fans, fan units or blowers, air handling units and air conditioning units. Make connections substantially airtight at all seams and joints.

Where the construction of the flexible connection or vibration isolator results in a cross sectional area of the connection which is less than 90 percent of the adjacent ductwork, the size of the connection shall be increased to provide a cross sectional area equal to or greater than 90 percent of the adjacent duct.

Provide flexible duct connections at both the intake and discharge connections for all fans and air handling units except as noted below.

Wall and roof fans that have integral motor/fan wheel isolation.

Air handling units where the fan is isolated from the intake and discharge connections by internal flexible connections or separations, and the unit is mounted without vibration isolators between the unit and the support structure.

Ductwork spacing and alignment for flexible connections shall be aligned to the tolerances of the flexible connection manufacturer, or plus/minus 1/4-in whichever is less. Bolts shall be torqued to the manufacturer's recommendations. Do not over tighten.

Where flexible connections are used as expansion joints, the manufacturer's precompression recommendations must be followed. When the temperature at installation differs from the temperature in the precompression recommendation, a correction shall be made.

3.4.02 Dampers. Install manual volume control dampers wherever it may be necessary to regulate air volume for system air balancing and where shown on the Drawings.

Install splitter dampers, where shown on the Drawings, to regulate air volume for system air balancing.

Install motorized and pneumatic actuated dampers when supplied by other trades.

3.4.03 Volume Extractors. Factory-fabricated volume extractors shall be installed at all main duct takeoffs to supply air diffusers.

3.4.04 Access Doors. Hinged access doors shall be installed where listed below, wherever shown on the Drawings and wherever access may be required for service, maintenance and adjustment.

Provide access doors at the following locations (minimum requirements):

Coils in ducts - both entering and leaving side.
Motorized or pneumatic actuated dampers - linkage side.
Duct mounted temperature controllers.
Freeze-stats.
Smoke detectors.
Plenums.
Fire dampers.
Smoke dampers.
Electric duct heaters.
Filter banks.
Manual dampers and splitters.
Inlet side of centrifugal fans.
Volume extractors.
Inlet and outlet ducts to fans and air handlers.
As necessary or required.

Where access doors are required in ductwork located above ceilings, coordinate the location of the access doors to clear the ceiling support system and to be accessible through the ceiling grid.

3.4.05 Duct Liner. Duct liner shall be shop installed on the interior surfaces of ductwork, where shown on the Drawings or as specified herein. Installation shall be made using a single thickness of duct liner and shall be in accordance with Duct Liner Application Standard by SMACNA. Liner shall be adhered with adhesive having a minimum of 90 percent coverage. Fasteners shall be spaced in accordance with SMACNA. After the duct has been formed the leading edges of the insulation that will be abutting another lined duct shall be spray-coated with fire-resistive adhesive. For ductwork with velocities exceeding 4000 fpm a metal nosing shall be installed at all transverse edges to secure the duct liner.

3.4.06 Blast Gates. Blast Gates shall be installed where shown on the Drawings. After final balancing of the system, drill a hole through both the frame and gate and insert a positive locking device, such as a pop rivet, to prevent moving the gate.

3.5 GRILLES, REGISTERS AND DIFFUSERS. The location of diffusers, registers and grilles shall be as shown on the Reflected Ceiling Plans and as shown on the ductwork drawings. The exact location of these devices shall be determined in the field in cooperation with the other trades. Install all devices in an approved manner in accordance with the manufacturer's recommendation.

3.6 FLEXIBLE DUCTWORK. Make connections, joints and terminations air tight as recommended by the manufacturer. Where joints are made to rigid sheet metal ductwork, apply 3M Company EC-800 sealer and the joint shall be drawn tight with a drawband. Collars shall be 2-in long minimum and sleeves shall be 4-in long minimum. Install flexible ducts with one duct diameter-radius elbows and cut as short as possible. Duct shall not be compressed and the length shall be kept short so minimum hangers or supports are required and static pressure losses are kept to a minimum. Sag in flexible duct shall not exceed 1/2-in/ft between duct supports.

3.7 FILLING IN SPACE AROUND DUCTWORK. To prevent sound passing through the area between the duct and the framed or cut opening in the floors, walls or partitions, pack mineral wool to completely fill the space the full depth of the opening. Whenever a fire-rated wall or floor is penetrated and a fire damper is not required, fill the space around the duct with a locally approved fireproof rope. At penetration, apply escutcheon plates on both faces of the wall to close the gap between the structure and the sides of the insulated or bare duct. Escutcheon plates shall be the same material as the duct for metal ducts and stainless steel for PVC ducts.

3.8 DUCT SUPPORTS AT FLOOR PENETRATION. Where vertical ducts pass through floor openings and a fire damper is not required, rigidly attach supporting angles to the ducts and anchor with expansion bolts to the floor or curb. Angles shall be of the same material as the duct for metal duct and stainless steel for PVC ducts, placed on the two long sides of the duct extending 3-in over edge of opening and shall not be less than the sizes recommended by SMACNA.

Remaining open area in the floor opening shall be sealed with a plate of the same material as the angle.

3.9 SUPPORTING OUTDOOR DUCTS. Roof top ductwork shall be installed using structural steel angles for support. Sizes of angles shall be as shown on the Drawings.

The vertical supporting angles shall be continuous full height of the duct and shall be bolted to same. Intermediate duct supporting angles and bottom plates shall be welded to the vertical angles. Weld all of these angles together to form a stiff continuous supporting unit for the duct. Paint angles with rust inhibitive primer after welding.

Slope ductwork to shed water.

3.10 DUCTWORK TERMINATIONS AT MASONRY OR CONCRETE. Where ducts terminate at masonry or concrete openings, place a continuous 2-1/2-in by 2-1/2-in by 3/16-in angle of the same material as the duct around the ductwork. Use stainless steel angles for PVC ductwork. Bolt the angle to the construction and make airtight by applying caulking compound on the angle before it is drawn down tight to construction.

Fasten plenums to concrete curbs with 3-in by 3-in by 1/4-in continuous angle. Concrete curbs are provided under another Division. Mount angle on a continuous bead of caulking compound and anchor to the curb on 16-in centers. Terminate duct at the curb and bolt to the angle. Seal the duct to the curb with a continuous bead of caulking compound. Apply neoprene filler strip to level curb surface as necessary

3.11 DUCTWORK GENERATED NOISE. All ductwork shall be free from pulsation, chatter, vibration or objectionable noise. After system is in operation, should these defects appear, correct by removing, replacing or reinforcing the work. No discreet tones will be allowed.

3.12 PLENUMS. Seal fresh air inlet and exhaust air plenums watertight at louvers or otherwise subject to water entrainment at all bottom joints and seams and up all vertical seams for a minimum of 12-in. Remove excess sealant before it sets hard. Where possible, pitch fresh air inlet and exhaust air plenums down towards the louver. Where it is not possible to pitch the plenum, provide a 1-in capped drain connection at the low point of the plenum.

3.13 TEST PORTS. Where shown on the Drawings and where required for testing and balancing, provide instrument insertion ports. Size and location of ports shall be coordinated with the Contractor performing air balancing. Seal ports with plastic snap lock plugs. When the ductwork will be insulated, extend the port to the face of the insulation and seal the vapor barrier to the port. When the ductwork is lined, extend the port into the duct to the inner surface of the duct liner.

In round ductwork provide 2 ports 90 degrees on centers. In rectangular ductwork provide ports as required by AABC or NEBB for a full traverse measurement.

As a minimum, ports shall be provided in the following connections:

All duct mains.

All duct branches unless all connections are diffusers, registers, or grilles and the total can be calculated by summing the readings for all of the connections.

All connections to tanks or hoods where there is no other access for taking a measurement.

A main duct is defined as one of the following:

A duct serving five or more outlets.

A duct serving two or more branch ducts.

A duct emanating from a fan or plenum.

All remaining ducts are considered branch ducts.

3.14 ADJUSTMENT. Start-Up and Temporary Operation

Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Owner.

3.15 PAINTING. Paint the outside face of all louver blank off panels and the interiors of unlined plenums and ductwork where connected to louvers. Prime and paint with two coats of flat black exterior paint. Painting shall be performed under this Section and shall be as specified in Division 9.

3.16 CLEANING OF DUCTWORK. Maintain all ductwork, fans, coils, air filters, outlets and other parts of the ductwork systems in a clean condition during installation. Clean complete ductwork systems prior to testing and air balancing. Secure cheese cloth over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

3.17 I NSTALLATION OF DUCTWORK INSULATION. Provide ductwork insulation as specified under Section 15250 and with thickness as specified under this Section.

Ductwork Insulation - Blanket Type (Type I-5)

Hot Ductwork (Heating and Ventilation)

Insulation Thickness - Concealed round and rectangular hot ductwork.

Supply ducts in heated spaces - 1-1/2-in

Supply ducts in unheated spaces - 2-in

Return ducts - 1-1/2-in

Mixed air ducts - 1-1/2-in

Cold and Hot/Cold Ductwork

Insulation Thickness - Concealed round and rectangular cold and hot/cold ductwork and exposed round cold and hot/cold ductwork.

All ducts in non-conditioned spaces 2-in

All ducts in conditioned spaces 1-1/2-in

Outdoor air ducts and plenums 2-in

Exhaust air ducts and plenums between shut-off damper and outdoors 1-1/2-in

Ventilation supply air ducts and plenums between shut-off damper and outdoors 2-in

Ductwork Insulation - Fiberglass Board Type (Type I-6)

Hot Ductwork

Insulation Thickness - Exposed rectangular hot ductwork.

Supply ducts in heated spaces 1-1/2-in

Supply ducts in unheated spaces 2-in Return ducts 1-1/2-in

Mixed air ducts 1-1/2-in

Cold and Hot/Cold Ductwork

Insulation Thickness - Exposed rectangular cold and hot/cold ductwork.

All ducts in non-conditioned spaces 2-in

All ducts in conditioned spaces 1-1/2-in

Outdoor air ducts and plenums 2-in

Exhaust air ducts and plenums between shut-off damper and outdoors 1-1/2-in

Ventilation supply air ducts and plenums between shut-off damper and outdoors 2-in

Ductwork Insulation - Closed Cell Foam Type (Type I-7)

Insulation Thickness - Outdoor mounted round and rectangular hot, cold and hot/cold ductwork.

All air ducts 2-in

Weatherproof all outdoor ductwork.

All ductwork, except as specifically noted below, shall be insulated unless approved in writing by the Engineer.

Exposed supply and return air ductwork located in the area it serves.

Exposed ventilation exhaust and relief ductwork located in the area it serves.

Exposed ventilation and relief ductwork located in areas that are neither heated
nor cooled.

Exposed outdoor air intake ductwork and plenums located in areas that are neither heated nor cooled.

Return air ductwork located in return air ceiling spaces above the area it serves, except where the return ductwork is installed in ceiling spaces with a roof above.

End of Section

SECTION 15950

ELECTRIC AUTOMATIC TEMPERATURE CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE. Furnish and install a complete electric automatic temperature control system as manufactured by Honeywell, Inc., Johnson Controls, Andover Controls or approved equal. The automatic temperature control (ATC) shall be as specified herein and shall perform the functions specified and shown on the Drawings. The control system shall be installed by competent mechanics, technicians and electricians approved by the automatic temperature control manufacturer. The manufacturer shall be fully licensed at the time of bid to do business in the job site area for each type of subsystem. Wholesalers, contractors, franchisers, dealers, or any firm whose principle business is not that of manufacturing and installing DDC controls will not be acceptable. The manufacturer shall provide a system to meet requirements of NFPA-72A, 72B, 72C and 72D, and shall be listed by UL. Each component of the system shall be, where applicable, UL listed for the intended service. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use.

The control system shall consist of all thermostats, temperature transmitters, flow switches, flow elements, transformers, alarms, flow transmitters, local flow controllers, ionization type smoke detectors, automatic valves and dampers, damper operators, control panels, electric relays, and other accessory equipment along with a complete system of wiring and conduit to fill the intent of the specification to provide for a complete and operable system. All control equipment shall be fully proportioning, except as noted otherwise.

HVAC equipment remote monitoring coordinate with Owner’s ovation facility management system contractor and fire alarm system contractor. Provide necessary equipment to achieve required control operation. Control sequences shall be as shown on the Drawings to be Automatic Temperature Control System. Coordinate with HVAC equipment manufacturers for controls furnished with the equipment.

1.2 RELATED REQUIREMENTS. The following shall be furnished and/or installed, under other sections:

Separable thermometer wells are included under Division 15.

All necessary valve pressure taps, water drain and overflow connections and piping are included under Division 15.

On magnetic starters the necessary auxiliary contacts, with buttons and switches in the required configurations are included under Division 15 and Division 16.

The necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified is included under Division 15. Locate baffles by experimentation and affix and seal permanently in place only after stratification problem has been eliminated.

Access doors or other approved means of access through ducts for service to control equipment is included under other Sections.

The installation of the following shall be under Division 15:

Automatic valves. Section 15950

Automatic dampers. Section 15950

The following are to be furnished and installed under other sections of Division 15, but will be integrated with the work of this Section:

Air Handling Units Section 15855.

Centrifugal Fans Section 15860

Heating Equipment Section 15550.

1.3 SUBMITTALS. Submit, in accordance with Section 01080, shop drawings and product data for the following:

Control drawings with composite wiring diagrams, and description of operation for all systems.

Panel layouts and nameplates lists for all local and central panels.

Valve and damper schedules showing size, configuration, sizing, pressure vs. flow diagrams for the fluid used, capacity, and location of all equipment.

Data sheets for all control system components.

Provide a recommended list of spare parts to be provided.

Sequence of operation descriptions.

Technical specification data sheets of each system component and device with indication of its use.

Complete listing of deviations from the system as specified.

Training manuals for each of the subjects required to be covered in training to include teaching plans, duration of each class, and maximum size of each class are to be submitted for review a minimum of three months prior to starting training. The manuals are to be broken down into the material required for each of the various courses. The submittal shall also include supplemental materials that will be used in the class and copies of overheads or slides if they are not in the preceding material.

All submittals shall contain a statement that Section 15501, and all other Sections have been read and complied with. The certification statement shall be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal. In general, corrections or comments or lack thereof, made relative to submittals during review shall not relieve the Contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The Contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.4 QUALITY ASSURANCE. The manufacturer must have a branch office facility with 50 miles of the project for at least 5 years, with technical staff and complete spare parts inventory and test and diagnostic equipment to keep systems in operation 24 hours per day 7 days per week. He/She shall have emergency service available in the local area for temperature control systems for which he/she is currently performing on-call emergency service 24 hours per day 7 days per week with a maximum response time of 4 hours. The automatic temperature control contractor shall have in his/her direct employ the personnel capable of detailed engineering, coordination, drafting, procurement, and expediting, scheduling construction, testing, inspection, installation, startup, calibration, and commissioning. The equipment to be furnished under this Section shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Several manufacturers are indicated as acceptable for some items of equipment in these specifications. The contractor shall be responsible for determining that all equipment supplied for this project is suitable for installation and proper operation in the space provided with fully adequate operating and maintenance access space.

The equipment furnished for installation under this Section shall be tested at the factory as standard with the manufacturer of the equipment. Unless otherwise indicated, the controls shall maintain space temperatures within plus or minus 0.5 degrees F, and space relative humidity within plus or minus 5 percent of their set points. Inspection by the Engineer’s representative or failure to inspect shall not relieve the Contractor of responsibility to provide materials and perform the work in accordance with the documents. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements. All work to applicable codes and Owner’s standard practice.

1.5 COORDINATION. All coordination responsibility is vested on the General Contractor.

1.6 DELIVERY, STORAGE AND HANDLING. All materials shall be inspected for size, quality and quantity against approved Shop Drawings upon delivery. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer. All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container. Instructions for servicing and startup of equipment in long term or prolonged storage shall accompany each item. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.7 ENVIRONMENT. All components, including data processing equipment, shall be suitable for operating in a normal plant environment without requirements for special temperature and humidity control.

1.8 WARRANTY. Provide one gear part and labor warranty after the completion of the project. Meet the requirements of Section 01170.

1.9 SPARE PARTS. Spare parts shall include all special items on the manufacturer's standard list of spare parts. In addition to special items, the following spare parts shall be provided:
Furnish all special tools required for normal operation and proper servicing of the equipment.

Spare parts shall include all items on the manufacturer's standard list of spare parts and the following for each unit:

One complete set of gaskets for each sealed unit.

Provide a minimum of 1 or 5 percent of the total units rounded to the next full unit whichever is greater for each size and rating of the following components:

Thermostats

Humidistat

Thermometers

Pressure gages

Control relays

Damper operators

Valve operators

Control transmitters

Control transformers

Photo-electric type smoke detectors

Ionization type smoke detectors

Provide a minimum of 4 or 10% of the total units rounded to the next full unit whichever is greater for each size and rating of the following components:

Panel light bulbs

Fuses

Pack spare parts in containers suitable for extended storage without deterioration of the parts. Containers shall be clearly labeled designating contents, pieces of equipment for which intended and equipment identification numbers. Spare parts shall meet the requirements of Sections 01180.

PART 2 - PRODUCTS

2.1 MATERIALS. All products and materials used in this project shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved in writing. Spare parts shall be guaranteed to be available for a minimum of five years after the completion of the project.

2.2 ATC EQUIPMENT.

2.2.01 Area Classification. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification. Special attention shall be given to hazardous areas specifically "Class I, Group D, Div. 1" and "Class I, Group D, Div. 2" to comply with code requirements for equipment selection and installation procedures. The type of enclosure shall be as specified in Division 16.

2.2.02 Room Thermostats. Temperature sensors shall be provided with concealed adjustment, exposed thermometer for displaying room temperature. All temperature sensors shall have an end to end (element to readout display) accuracy of plus or minus 0.5 degree F. Temperature sensors shall be of the wire-wound resistive element type (RTD) using either nickel or platinum alloy as the resistive element. All temperature sensors shall have an end to end (element to readout display) accuracy of plus or minus 0.5 degree F. Thermostats shall be of the heavy duty all metal type 24 volt, provided with concealed adjustment and exposed thermometer. Provide rugged clear plastic-locking cover and steps of control as required. Room thermostat and temperature sensors mounted on exterior walls shall be provided with insulated mounting plates. All room thermostats and sensors shall be mounted 4-ft-0-in above finish floor except where otherwise indicated on the Drawings or specified herein or as required by code. Electric thermostats in corrosive areas shall be installed in electric boxes with remote stainless steel bulbs.

2.2.03 Low Temperature Duct Mounted Safety Thermostat. Electric low temperature thermostats shall be duct mounted probe type. These thermostats shall be two- position with manual reset.

2.2.04 High Temperature Safety Thermostat. Electric high temperature thermostats shall have a bimetal type sensing element with at least a 10-in insertion length. These thermostats shall be two-position manual reset type.

2.2.05 Static Pressure Sensors. Shall be adjustable, set point proportional type, with adjustable range in inches of water to meet the performance or function specified.

2.2.06 Ionization Type Smoke Detectors (Four Wire Type). Furnish and install ionization type smoke duct detectors downstream of the air filters and ahead of any branch connections in air supply systems wastewater process areas as shown on the Drawings and having a capacity greater than 2,000 cfm. In addition, furnish and install ionization type smoke detectors all exhaust systems serving wastewater process areas as shown on the Drawings and having a capacity greater than 2,000 cfm. Smoke detectors shall also be installed where shown on the Drawings and where called for on the control sequences.

Duct smoke detector shall be suitable for expected air velocity range, temperature range, humidity range, and contaminant range in the airstream as indicated on the associated HVAC Equipment Unit Schedules. The detector housing shall be listed per UL 268A specifically for use in air handling systems. The detector housing shall be equipped with an integral mounting base capable of accommodating either photo electronic or ionization detector heads. It shall be capable of local testing via remote testing station. The duct detector housing shall incorporate an airtight smoke chamber in compliance with UL 268A, Standard for Smoke Detectors for Duct Applications. The housing shall be capable of mounting to either rectangular or round ducts without brackets. An integral filter system shall be included to reduce dust and residue effects on detector and housing, thereby reducing maintenance and service. Detectors shall be provided with two sets of DPDT 10 amp dry contacts in the smoke detector housing to provide smoke alarm signals. One contact is to be used by the ATC systems, and the second is for use by Division 16 for interface to the fire alarm systems.

Remote test switch and alarm indicator stations shall be furnished for all duct smoke detectors as specified above. The installation and wiring of the remote stations will be provided under this Section. The remote test stations shall be wall mounted within the visible location of the smoke detector and easily accessible from the floor.

2.2.07 Motorized Control Dampers. Source Quality Control: Motorized dampers for air intake shall allow a maximum air leakage of 5 cfm per square foot at 4 inches water gage static pressure. Design for maximum 6 inches water gage static pressure differential and 4,000 feet per minute approach velocity.

Type: Parallel Blade similar to Ruskin CD36.

Reference: SMACNA Standards.

Construction:

Tight seal ultra-low leakage construction.

Galvanized steel

Blades

Blade Shafts: 1/2-inch plated steel

All stainless steel construction where shown

Provide thermal blade edge seals for air tight damper closure.

Blade ends shall be sealed with spring loaded continuous strips fastened to frame.

Bearings: Bearings at each end of shaft.

Blades to be designed for minimal resistance to air flow.

Linkage brackets, connecting rods an mounting hardware. Provide bird screen where required.

Approved Manufacturer shall be:

Ruskin

Louvers and Dampers

American Warming

Arrow

or equal

2.2.08 Electronic Damper Actuators. Electronic actuators, less than 600 in-lb of rated torque, shall have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification. Electronic actuators used on valves shall be designed to directly couple and mount to a stem, shaft or ISO style- mounting pad. Actuator mounting clamps shall be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable. Actuators shall be two position as required and be factory or field selectable. Actuators shall have visual position indicators and shall operate in sequence with other devices if required.

Two sets of DPDT switches with fully adjustable set points shall be provided to activate panel indicators and provide signals for equipment operation. Actuator shall have an operating range of minus 22 to 122 degrees F. Proportional actuators shall accept a 0 to 10 VDC or 0-20 mA input signal and provide a 2 to 10 VDC or 4-20 mA (with a load resistor) operating range. Actuators shall be capable of operating on 24, VAC and Class 2 wiring as directed by the application. Power consumption shall not exceed 10 VA for AC, including 120 VAC actuators and 8 watts per actuator for applications. Provide transformer as required. NEMA 2 rated actuators shall be provided with a three foot (minimum), prewired, electrical cable. Actuators requiring removal of the actuator cover for access to wiring terminals, exposing electronics, printed circuit boards to damage, are unacceptable. Actuators shall have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.

For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Spring return actuators shall be capable of CW or CCW mounting orientation. Spring return models >60 in-lb will be capable of mounting on shafts up to 1.05-in diameter. Spring return actuators with more than 60 in-lb of torque shall have a manual override metal crank. Upon loss of control signal, a proportional actuator shall fail open or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator shall maintain the last position.

Actuators using “on-board” chemical storage systems, capacitors or other “on-board” non-mechanical forms of fail-safe operation are unacceptable.

Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required. Dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators. Dual mounted actuators using additional anti-rotation strap mechanical linkages, or special factory wiring to function are not acceptable. Actuators in a tandem pair must be “off the shelf” standard actuators ready for field wiring. Damper actuators will not produce more than 62 dbA when furnished with a mechanical fail-safe spring. Non-spring return actuators shall conform to a maximum noise rating of 45 dbA with power on or in the running or driving mode. Where special classifications are shown on the electrical drawings damper actuators shall be provided with suitable enclosures. NEMA 4X enclosures shall be as specified in Division 16 and shall have a shaft seal and all electrical connections shall be suitable for the space classification. Enclosure shall be UL listed.

Explosion-proof enclosure shall be suitable for Class I, II and III as specified in Division 16. A suitable shaft seal must be provided. Housing shall be cast copper fill aluminum with stainless steel fasteners and shall be UL listed. Housing shall be suitable for NEMA 4, 7 and 9.

Local Direct Digital Control (DDC) Panels - General: Local DDC panels shall be standalone microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each local DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the control functions. Local panel shall be capable of communicating with Owner’s Ovation Facility Management system

Hardware Override Switches: As indicated in the control sequences, the operator shall have the ability to manually override automatic or centrally executed commands and reset alarms at the DDC panel via local, point discrete, onboard hand/off/auto operator override switches for binary control points and gradual switches for analog control type points. These override switches shall be operable whether the panel is powered or not.

Local Status Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Indicator lights called for on the control sequence shall be on the face of the panel. Also provide audible alarm where shown.

Integrated On-line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.

Power Failure Restart: In the event of the loss of normal power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-Volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours. Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.

All panels shall be provided with lugs, brackets or field supplied devices to allow the panel to be firmly fastened to the structure. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic loads for the area and type of application.

Miscellaneous Devices - Provide all the necessary relays, limit switches, positioners, valves, clocks, transformers, etc, to make a complete and operable system. Locate these devices on local ATC panel unless specified otherwise.

Set points on thermostats, temperature controllers, humidistats, humidity controllers and static pressure controllers shown on the Drawings are indicative only and devices shall be adjustable above and below such set points. If a set point is not stated, the control range of devices shall be suitable for the intended service. Range of devices shall be approximately 50 percent greater in both directions than span of variable, with a minimum of 25 degrees and a maximum of 100 degrees F for air systems. Thermometers - Thermometers shall be flush mounted on local panels. These thermometers shall be of the dial type, minimum 3-in diameter.

Flow Switches and Sensors - Duct air flow elements for modulating control shall be of the multipoint, self-averaging pitot tube, differential pressure type. Each element shall have air straightening vanes. These elements shall be fabricated of heavy-gauge, galvanized steel welded casing with 90 degree connecting flanges in a configuration and size equal to that of the duct it is mounted into. The maximum allowable unrecovered pressure loss through the element shall not exceed 0.065-in w.c. at 1000 fpm. Element accuracy shall be plus or minus 1 percent of actual flow rate over the flow range. Repeatability shall be plus or minus 0.1 percent of the actual flow rate over the flow range. Rangeability shall be guaranteed to meet flows as specified. Flow switches for clean air applications to include supply and makeup air systems shall be adjustable differential pressure type with an adjustment range suitable for the application including pressure range, temperature range, and expected containment range. Switches shall be arranged for sensing system velocity pressure through the use of a pitot tube arrangement. Pitot tubes shall be accessible and removable for inspection and maintenance without disturbing wiring connections or transmitters. Tube shall be stainless steel. Flow switches for general HVAC exhaust applications shall be vane (paddle) type switches suitably selected for the expected duct velocity, pressure range, temperature range, humidity range, and expected contaminants in the air stream. Positioned in the ductwork to be accessible and located so as to avoid nuisance tripping and unreliable operation due to flow turbulence. Vane and vane blocks shall be Type 316 stainless steel.

Switches and control wiring shall be arranged so switch is easily removable from ductwork to permit vane inspection, without disconnecting the wiring.

Thermal dispersion flow sensors shall be set and calibrated after air balancing has been completed. Unless otherwise noted, the set points for high or low shall be plus/minus 10 percent. For high high, or low low shall be plus/minus 15 percent. When the sensor has a varying speed response for start up and shut down, the shorter time response shall be used for the system alarm or shut down signal.

Where specifically called for on the Drawings or in the control sequences, current measuring devices shall be used for flow monitoring. Devices shall measure the actual current for the fan motor and compare it to a predetermined range. The range is to be determined by measurement during system balancing. The use of sensors that only respond to a condition of current or no current are not acceptable.

Electronic Sensors - All mixed air and coil discharge sensors shall utilize industry standard 4-20 mA sensors with averaging elements. Sensing elements shall be a minimum of 25-ft and temperature sensed shall be averaged over the entire length of the element. Thermistor type sensors will not be acceptable for this application. Space type sensors shall have an accuracy of plus/minus .5 degrees over sensed temperature range (20 to 120 degrees F).

Well type sensors used for liquid immersion shall have stainless steel removable wells. Sensing element shall have an accuracy of plus/minus .5 degrees over range (70 to 220 degrees F or 20 to 120 degrees F) of the sensor. Each sensor shall have a suitable electrical box to enclose all wiring connections.

Temperature control wells shall be installed according to manufacturer's recommendations.

2.3 ELECTRIC WIRING. All field wiring (other than power wiring) between control cabinets, control devices, unitary control panel and control terminals in motor control centers shall be furnished under this Section and shall conform to the requirements of Division 16. Wiring to suspended and cabinet unit heaters and their thermostats shall be considered power wiring. All interlocking wiring within MCC shall be done by Division 16. Refer to the electrical drawings for NEMA enclosure types.

Installation of all conduit, wire, sleeves, outlet boxes, insulating bushings, system cabinets, terminal boxes, pull boxes, junction boxes, inserts, anchors, system devices, etc, shall be in accordance with the appropriate requirements of Division 16, and in accordance with sections of the current edition of the local codes for signal systems and electrical systems.

Wiring shall be run in rigid steel conduit except in dry locations above ceilings and wood or metal stud framed partition walls, where EMT may be used. Conduit, boxes and fittings and their installation and testing shall be as specified in Section 16110.

In the event of any conflict among referenced codes, current editions of the applicable local codes shall take precedence for interpretation of "Signal System" installation requirements.

Installation of sensor wiring in finished areas shall be concealed whenever possible. Where concealed wiring is not possible, written approval for exposed work must be obtained from the Engineer prior to installation.

A power supply 115V, single phase, 60 Hz, 20 Amp circuit for ATC, requirements will be taken from local control panel. Power shall not be taken from the control power transformers of the motor control center. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.) All wiring in mechanical, electrical or service rooms or where subject to mechanical damage shall be installed in conduit at levels below 10- ft. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

All wire to device connections shall be made at a screw type terminal block or screw type terminal strip. All wire to wire connections shall be at a screw type terminal block. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals. All wiring shall be installed as continuous lengths, with no splices permitted between termination points. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations. Size of conduit and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and code requirements, except as noted elsewhere. Include one pull string in each conduit (1-in) or larger. Use coded conductors throughout with conductors of different colors.

Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment and control panel enclosures unless they also contain Class 1 starters.

Conceal all conduits, except within mechanical, electrical or service rooms. Install conduits to maintain a clearance of 6-in from high temperature equipment. Secure conduits with conduit clamps fastened to the structure and spaced accordingly to code requirements. Conduits and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork. Comply with Division 16 requirements where conduit crosses building expansion joints. Install insulated bushings on all conduit ends and openings to enclosures. Seal top end of all vertical conduits. The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site. Flexible metal conduits and liquid tight, flexible metal conduits shall not exceed 3-ft in length and shall be supported at each end. Flexible metal conduits less than 1/2-in electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid tight, flexible metal conduits shall be used. Conduits must be rigidly installed, adequately supported, properly reamed at both ends and left clean and free of obstructions. Conduit sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes.

PART 3 - EXECUTION

3.1 INSTALLATION. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

3.2 INSTRUCTION AND ADJUSTMENT. Upon completion of the project: Completely adjust and calibrate, ready for use, all thermostats, valves, damper operators, relays, thermometers and recorders, etc, provided under this Section.

Furnish four instruction manuals covering the function and operation of the control and automation systems on the project for the use of the Owner's operating personnel. A competent technician shall be provided for a period of 16 hours for instruction purposes.

The system contractor shall provide complete system documentation at acceptance time, as specified herein. Documentation shall be provided in four sets, unless otherwise elsewhere in this Section. Documentation shall include the following:

All data specified in the Paragraph 1.03 above, in its final as-built approved form.

As-built interconnection wiring diagrams, or wire lists, or list of the complete field installed system with complete, properly identified, ordering number of each system component and device.

3.3 CONTROL SEQUENCES. HVAC equipment will operate with the sequences of operation shown on the drawings. The following will apply to all sequences.

All sequences are reversible unless otherwise noted.

Manual reset of control functions with manual reset will be at the local control panel unless otherwise noted.

Where required to prevent nuisance shut downs of systems, provide time delay of sensors to allow system start up before the sensors are activated. This would include, but not be limited to low temperature freeze protection on 100 percent outdoor air units.

The ATC contractor shall provide all connections, relays and other devices required to operate the system under the control of the firefighter control panel.

End of Section

SECTION 15955

BUILDING SYSTEM CONTROLS

PART 1 - GENERAL

1.1 SCOPE. This section covers the design, furnishing, and installation of control systems and instrumentation associated with the heating, ventilation, and air conditioning (HVAC) equipment and systems including all associated equipment, devices, and controls necessary for proper operation.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. The control and instrumentation shall be designed and coordinated for proper operation with the controlled equipment and materials furnished under other sections, under other contracts, and with related existing equipment. All controls devices and instruments shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the device manufacturer and controlled equipment manufacturer unless exceptions are noted by Engineer.

Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment or instrumentation are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

Review of drawings submitted prior to the final determination of related equipment shall not relieve Contractor from supplying systems in full compliance with the specific requirements of the controlled equipment. Controlled equipment and materials may include, but will not be limited to, fans, pumps, actuators, measuring devices, supervisory control equipment, cable, conduit, and piping as described in other sections. Installation drawings shall be prepared for interconnecting wiring and instrument tubing between the controlled equipment and equipment furnished in this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system. Contractor shall provide coordination with the other contractors and supervision of installation as needed during construction.

Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. The temperature controls supplier shall design and furnish a complete and functional control system in accordance with the drawings, specifications, and sequence of operation. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation

Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper and valve actuators, temperature/digital control panels, motor starters, and the HVAC equipment, shall be furnished and installed as specified in the control circuits paragraph. Cable and conduit for all HVAC power circuits shall be as specified in Master Specification Section 16050, Electrical General Requirements.

Motor starters will be provided with terminal blocks for the termination of conductors for operational control and run/off status of the equipment. Refer to the electrical schematics for additional information.

The temperature controls supplier shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on suppliers representatives for temperature controls shall be included with the submittals.

Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.03 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

When indicated by the applicable codes, panel assemblies, materials, and equipment shall be approved, identified, labeled, or listed by Underwriters' Laboratories or other testing organization acceptable to the governing authority.

1.2.04 Power Supply. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or necessary for a properly operating system.

1.2.05 Metal Thickness. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.2.06 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during start-up or shutdown and shall not waste lubricants.

Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted, the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.3 MECHANICAL IDENTIFICATION.

1.3.01 Number Plates. All valves, panels, and control equipment denoted on the drawings by a symbol and an identifying number shall be provided with an identifying number plate. The identifying text shall be identical to the symbols indicated herein or on the drawings and shall be located in a conspicuous place. Number plate symbols and numbers shall be capitalized block letters with a minimum height as indicted below.

Item Identified	Letter Height, inches (mm)
Control Equipment Items	1/2 (13)
Control Panels	3/16 (5)

Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around. Lettering shall be placed in one row where practicable; however, where required due to excessive length, lettering shall be placed on more than one row and centered.

Number plates shall be in the form of nameplates unless equipment is too small to accommodate the specified nameplate, then tags shall be used. Nameplates shall have black baked enamel letters on anodized aluminum plateNameplates and tags shall be at least 12 gage thickness with engraved or imprinted symbols. Tags shall have smooth edges and shall be a minimum diameter of 1-1/2 inches (38 mm).

Tags shall be installed with corrosion-resistant chains or straps. Nameplates shall be installed with corrosion-resistant mechanical fasteners. Nameplates shall be firmly secured to temperature control panels with stainless steel panhead screws.

1.3.02 Valves. Valves that have been assigned an identification number shall be identified with tags.

1.4 SUBMITTALS.

1.4.01 Drawings and Data. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals. Device tag numbers indicated on the drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the drawings.

Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring and instrument piping with all terminals and ports accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

Control valve schedule with each valve identified by the designations used herein and on the drawings and cross-referenced to the manufacturer's equipment data sheet or bulletin. The schedule shall also list complete sizing data for each valve, giving design flow and temperature or pressure, actual pressure drop, normal position, fluid, actual close-off rating, actual capacity index, and any other pertinent data.

Sequence of operation for each system corresponding to the control schematics.

Detailed panel construction drawings, including description of all materials and finishes, complete internal wiring and piping schematics, panel face layout, and complete data on all mounted components.

Space thermostat schedule indicating the types of covers and means of adjustment for each space.

Conduit and wire types.

1.4.02 Operation and Maintenance Data and Manuals. Operation and maintenance manuals with Master Specification Section 01160, Training and Operation & Maintenance Manuals shall be supplied, and shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manual. Equipment designations used shall correspond to those indicated on the drawings.

Operation and maintenance manuals shall include the following:

Equipment function, normal operating characteristics, and limiting conditions.

Assembly, installation, alignment, adjustment, and checking instructions.

Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 QUALITY ASSURANCE. The equipment furnished for installation under this section shall be tested according to the manufacturer's standard procedures.

1.5.01 Contractor's Qualification. The entire system shall be designed, coordinated, and supplied by a qualified Contractor who is regularly engaged in the business of designing and building instrument and control systems for heating, ventilating, and air conditioning equipment. The Contractor shall have at least 5 years of documented experience in designing and installation of the products specified and shall be employed by the control manufacturer or be an approved certified installer with full responsibility for proper operation of the control including startup and calibration of each component in the controls system.

1.5.02 Manufacturer Experience. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5.03 Tolerances. Unless otherwise indicated, the controls shall maintain space temperatures within ± 2°F (1.1°C), and the relative humidity within ± 5 percent of the setpoint.

1.6 DELIVERY, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools .

1.7 EXTRA MATERIALS. Extra materials shall be packaged in accordance with Master Specification Section 01180, Equipment, Materials, Parts and Tools, with labels indicating the contents of each package. Each label shall indicate the manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

Thermostats: 1 of each type.

Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be designed to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. A complete system of automatic temperature controls shall be furnished and installed to accomplish the control described in the sequence of operations. All control equipment shall be compatible for operating with the control system provided.

The control system shall consist of all necessary thermostats, control valves, switches, relays, timers, and gauges in accordance with the sequence of operation indicated on the drawings. Technical engineering services, including but not limited to engineering, programming, installation supervision, commissioning, and troubleshooting shall be provided for a complete and functional system.

2.3 ACCEPTABLE MANUFACTURERS. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; Andover Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2.4 MATERIALS.

2.4.01 Anchor Bolts and Expansion Anchors. Anchor bolts, expansion anchors, nuts and washers shall be as indicated in Master Specification Section 05550, Anchor Bolts and Expansion Anchors, unless otherwise indicated on the drawings.

2.4.02 Electric/Electronic Control Systems. Electric/electronic control systems shall be furnished and installed as indicated on the drawings and specified herein.

2.4.03 Thermostats.

Two Position Wall Mounted Thermostats. Two position wall mounted thermostats shall be Honeywell "T631A Airswitch", Penn Controls "A19BAC-1", Siemens Building Technologies, or approved equal.

Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 3.5°F (2°C). The thermostats shall have a spdt switch rated for 1 horsepower (0.746 W).

Two Position Corrosion Resistant Wall Mounted Thermostats. Two position wall mounted thermostats located in wet or corrosive environments shall be Honeywell "T631F", or approved equal.

Two position corrosion resistant wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 3.5°F (2°C). The thermostats shall have a spdt switch rated for 1 horsepower (0.746 kW).

Two Stage Wall Mounted Thermostats. Two stage wall mounted thermostats shall be Honeywell "T631B Airswitch", Penn Controls "A28AA-4", Siemens Building Technologies, or approved equal.

Two stage wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35°F to 100°F (2°C to 38°C) with a nonadjustable differential of 2°F (1.1°C) for each stage and 3.5°F (1.9°C) between stages.

Low Limit Thermostats. Low limit thermostats shall be Honeywell "L480", or Penn Controls "Model A11A-1", Siemens Building Technologies, or approved equal.

Low limit thermostats used for low temperature cutout shall be capillary, line-voltage type, complete with spst switches. The sensing elements shall be at least 20 feet (6 m) long. The thermostat shall be responsive to the lowest temperature along the measuring element, shall have a range of approximately 35°F to 45°F (2°C to 7°C), and shall be manually reset.

Remote Bulb Thermostats. Remote bulb thermostats shall be Honeywell "T675A", Penn Controls "A19ABC-24", Siemens Building Technologies, or approved equal.

Remote bulb thermostats shall be line voltage, fast response type. The thermostats shall have a range of approximately 0°F to 100°F (-18°C to 38°C) with an adjustable differential of 3°F to 10°F (1.7°C to 5.6°C). The thermostat shall include a capillary holding frame suitable for duct mounting.

Modulating Wall Mounted Thermostats. Modulating, wall mounted thermostats shall be Honeywell "Model T92", Penn Controls "Model T80ABA-1", Siemens Building Technologies, or approved equal.

Modulating, wall mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have an operating range of approximately 63°F to 87°F (17°C to 31°C) with a throttling range of approximately 1.5°F to 6.5°F (0.8°C to 3.6°C).

Modulating Duct Mounted Thermostats. Modulating, duct mounted thermostats shall be Honeywell "Model T991", Penn Controls "Model A80ABA-2", Siemens Building Technologies, or approved equal.

Modulating, duct mounted thermostats shall be modulating, proportional control, low voltage type. The thermostats shall have a range of approximately 10°F to 90°F (-12°C to 32°C) with an adjustable throttling range of approximately 5° F to 24°F (3°C to 13°C), and shall be furnished with a duct mounting kit.

Explosionproof Thermostats. Explosion-proof wall-mounted thermostats controlling explosionproof equipment in Class I, Division 2, Group D areas shall be Honeywell "Model T6051B", Johnson Controls "Model A19BUC-2", Siemens Building Technologies, or approved equal.

Explosionproof wall-mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 45°F to 85°F (7°C to 29°C) with a nonadjustable differential of 1°F (0.6°C). The thermostats shall have a spdt switch rated for 10 amperes at 120 volts ac.

Duct-mounted thermostats controlling explosionproof equipment in Class I, Division 2, Group D areas shall be Indeeco "Model T94A-70", or approved equal.

Non-programmable Wall Mounted Thermostats. Non-programmable, wall mounted thermostats shall be Honeywell "Model T874", Penn Controls, Siemens Building Technologies, or approved equal.

Non-programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, electromechanical type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 42°F to 88°F (6°C to 31°C) with the following features:

- Automatic heat/cool changeover
- Auxiliary heat LED
- Tamper-resistant cover with thermometer.

Where an economizer is used, the non-programmable thermostat shall be suitable for interfacing with the economizer control package.

Programmable Wall Mounted Thermostats. Programmable, wall mounted thermostats shall be Honeywell "Model T7300", Penn Controls, Siemens Building Technologies, or approved equal.

Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45°F to 95°F (7°C to 35°C) with the following features:

- 7 day programming with 2 occupied/unoccupied periods per day.
- Automatic heat/cool changeover.
- Battery backup.
- Digital display.
- Temporary override of setpoints.
- 2 configurable LED's.

Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

2.4.02.02 Humidistats. Humidistats, denoted by the symbol "H" and an identifying number, shall be Honeywell "H46C", Johnson Controls, Siemens Building Technologies, or approved equal.

Humidistats shall have a nylon element coupled to a spst mercury contact that closes on a rise in relative humidity. Each humidistat shall have an adjustable range of 20 to 80 percent relative humidity and an operating differential of approximately 5 percent relative humidity.

2.4.02.03 Economizer Control System. A complete economizer control system shall be provided for the system as indicated in the sequence of operations on the drawings. The economizer control system shall be Honeywell "Model W6215", or approved equal. The economizer control system shall be electronic solid state type with logic module, temperature and enthalpy sensors as required for the application. The economizer system shall provide temperature, single enthalpy, or differential enthalpy control and shall be suitable for use with the space thermostat. The economizer control system shall be mounted in the temperature control panel associated with the controlled system.

2.4.03 Direct Digital Control Systems.

2.4.03.01 General. The Direct Digital Control (DDC) system shall be furnished and installed as indicated on the drawings and as specified herein. The DDC system shall be capable of integrating multiple HVAC system functions, including data sharing, alarm/event management, scheduling, trending, and device/network management.

The DDC system shall consist of, but shall not be limited to, the following:

Stand-alone system and zone level DDC controllers for control of air handling units, air terminal units, heating water system, and chilled water system.

A network bus for communication between controllers.

A network control unit (NCU), if necessary to accomplish the control strategies described in the Sequence of Operation.

Portable operator interface terminal.

Sensors, transmitters, detectors, and accessories necessary for proper operation of the system and equipment.

Personal computer as necessary for alarm management, configuration, and programming.

The system shall be of modular design, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC controllers, and operator devices.

The failure of any single component, including the NCU, or network connection shall not interrupt the execution of control strategies at other operational devices. Master controllers shall employ a spare control strategy to ensure control execution is not interrupted.

2.4.03.02 Networking/Communications. The DDC system shall be an integrated network system configured to perform the functions described in the sequence of operation. The system's design shall include provisions to expand or modify the network.

The DDC controllers and NCU shall be capable of full stand-alone operation allowing execution of control strategies with default values when bus communication and global data is not available. In addition, the controllers shall reside on the network so that communications may be executed directly to and between DDC controllers, and shall allow intelligent interface for program changes, command inputs, and output of operating data.

The digital control system shall allow all operator devices, either network resident or connected via dial-up modems, to access all point status and application report data on the network. Access to system data shall not be restricted by the hardware configuration of the DDC system.

When it would be inefficient or impractical to provide multiple sensors, the digital control system shall provide global data sharing or global point broadcasting between DDC controllers.

The network design shall provide:

Data transfer rates for alarm reporting and quick point status from multiple DDC controllers.

Support of any combination of DDC controllers. A minimum of 20 DDC controllers shall be supported on a single local network or control bus. The bus shall be addressable for up to 20 DDC controllers.

Detection of single or multiple failures of DDC controllers or the network media.

Error detection, correction, and re-transmission as necessary to guarantee data integrity.

Commonly available, multiple-sourced, networking components shall be used.

Use of an industry standard protocol, such as Optomux, and IEEE RS-485 communications interface at the network interface level.

Each DDC controller, air terminal unit zone thermostat, and the NCU, if provided, shall include provisions for connection to a portable operator's terminal which will allow the system operator to interface with the control network. The operator's terminal shall be mounted at the digital control panel as required, and shall be available for connecting to remote DDC controllers. The portable operator's terminal shall include a keypad and full English language display. A touchpad, menu-driven display shall also be acceptable. If the Echelon zone communication bus is utilized, then a 50 foot (15 m) operators terminal cable maybe provided in lieu of the room sensor jack connection.

The operator's terminal shall have multiple-level password access protection to allow the user to limit control, display, and data base manipulation capabilities for each user, based upon an assigned password. The passwords shall be exactly the same for all operator devices with a minimum of three levels of access. A minimum of 4 passwords shall be supported at each digital controller. The same passwords shall be used at any controller for the specific user.

Operators will be able to perform only the commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined for the access level of the password used to log-on. User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

The operator interface shall allow the operator to perform commands including, but not limited to, the following:

Start up or shut down selected equipment.

Adjust setpoints.

Add/modify/delete time programming.

Enable/disable process execution.

Enable/disable totalization for each point.

Enter temporary override schedules.

Define holiday schedules.

Change time/date.

Enter/modify analog alarm limits.

Command controller outputs for maintenance/test operations.

View and acknowledge a minimum of the last 50 alarms.

2.4.03.03 System Software Features. All necessary software to form a complete operating system shall be provided as an integral part of the DDC system, and shall not be dependent upon a higher level computer for execution. As a minimum, the software shall include the following:

Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

Energy Management Applications: The DDC system shall be able to perform any or all of the following energy management routines:

- Time of Day Scheduling
- Calendar Based Scheduling
- Holiday Scheduling
- Optimal Start
- Optimal Stop
- Heating/Cooling Interlock
- Demand Limiting
- Load Rolling

All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. The programs shall be applied to building equipment described in the Sequence of Operations.

Programming Capability: The DDC system shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.

Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

- Any system-measured point data or status
- Any calculated data
- Any results from other processes
- Boolean logic operators (and, or)

Process Triggers: Configured processes may be triggered based on any combination of the following:

- Time of day
- Calendar date
- Other processes
- Events (e.g., point alarms)

Data Access: A single process shall be able to incorporate measured or calculated data from any DDC controller and shall be able to issue commands to points in any and all other DDC controllers on the local network.

Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC controller and the NCU, if necessary, shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. Alarms shall be displayed and acknowledged via the portable operator's terminal or other device provided by the System Supplier.

The DDC system's ability to report alarms shall be affected neither by operator activity at the local I/O device, nor by communications with other DDC controllers on the network.

Point Change Report Description: All alarm or point change reports shall include a verbal description of the point and the time and date of occurrence.

Prioritizing: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point.

The user shall be able to identify the conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

Alarm Messages: In addition to the point description and the time and date, the user shall be able to display or store an alarm message to more fully describe the alarm condition or direct operator response. Each DDC controller shall be capable of storing at least 20 alarm messages. Each message may be assignable to any number of points in the panel.

2.4.03.04 <u>DDC Controllers</u>. Each DDC controller shall operate as a stand-alone controller capable of performing its specified control strategies independently of other controllers in the network. Each DDC controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.

Each DDC controller shall have sufficient memory to support its own operating system and data bases, including the following:

Control processes.

Energy management applications.

Operator I/O (portable service terminal).

The operator interface to any DDC controller point data or programs shall be through the portable operator's terminal connected to any DDC controller on the network. In addition, a communication bus shall be provided for connection to an Owner furnished personal computer. A software package and necessary interface card shall be furnished and installed on the computer to allow communication in text format with the DDC system.

DDC controllers shall directly support the temporary use of a portable service terminal that can be connected to the DDC controller via an input jack located on the zone temperature sensor or the controller. If the Eschelon Lonworks Bus is utilized at the terminal unit controller level, a portable bus control/display operator's terminal shall be provided. The capabilities of the portable service terminal shall include, but not be limited to, the following:

Display temperatures.

Display status.

Display setpoints.

Display control parameters.

Override binary output control.

Override analog setpoints.

Modification of gain and offset constants.

All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the DDC controller.

Each controlled device or function shall be a separate output of the DDC controller.

2.4.03.04.01 Air Terminal Unit Controllers. Air terminal unit controllers shall be configured to support single duct cooling with hot water coil and remote hot water convective heating. The air terminal unit controllers shall support the following types of point inputs and outputs:

Cooling outputs (proportional).

Box heating outputs (proportional).

Air terminal unit controllers shall support the following library of control strategies to address the requirements of the sequences described in the sequence of operation and for future expansion:

Daily schedules.

Occupied/unoccupied mode.

Morning warm-up mode.

Temporary override mode.

Temporary comfort mode.

Boost (occupant warmer/cooler control).

The controller interface to the zone temperature sensor shall allow an optional momentary switch to change the mode of the controller from unoccupied to occupied mode.

The controller interface to the zone temperature sensor shall allow an optional momentary switch or setpoint pot to override the controller's output to full heating or cooling as necessary. This command shall be active for a preset amount of time to anticipate a substantial change in the room's heating or cooling load via set-point adjustment.

Continuous Zone Temperature Histories: Each air terminal unit controller shall automatically and continuously maintain a history of the associated zone temperature. This allows users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two temperature samples per hour shall be stored.

Alarm Management: Each air terminal unit controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

Direct digital control (DDC) panels associated with the air terminal units are not shown on the drawings but shall be located at the respective volume control unit location.

2.4.03.04.02 Air Handling Unit (AHU) Controllers. The AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the sequence of operation, and for future expansion:

Mixed air-single path.

VAV system, including supply and return fan speed control.

Heating and cooling control.

System economizer.

Low temperature safeties/shutdown sequence.

Smoke detection/purge/vent protection.

Supply and return airflow measurement.

User defined points alarming for:

a. High filter pressure loss.

b. High/low duct static pressure.

c. Freeze detection.

d. Smoke alarms.

AHU controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

AHU controllers shall have a library of control routines and program logic to perform the sequence of operation.

Each AHU controller shall automatically and continuously maintain a history of the associated zone temperature and air system temperatures to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

Each AHU controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.4.03.04.03 Heating Water System Controller. The heating water system controller shall support, but not be limited to, the following configurations of systems to address current requirements as described in the sequence of operation and for future expansion:

Boiler sequencing.

Boiler firing rate.

Boiler blending valve control.

Primary heating water loop temperature control.

Secondary heating water loop temperature control.

Heating water pump control.

User defined points alarming for:

a. High/low water temperature.

b. Low water flow.

The heating water system controller shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally stand-alone fashion.

The controller shall have a library of control routines and program logic to perform the sequence of operation.

The controller shall automatically and continuously maintain a history of the associated loop supply and return heating water temperature to allow users to quickly analyze equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

The controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.4.03.05 Sensors and Controllers.

Wall-Mounted Temperature Sensors. Space temperature sensors shall use a precision type accurate to ± 0.5°F (0.3°C) over a temperature range of 40°F to 90°F (5°C to 32°C). The assembly shall be installed within a ventilated off white enclosure suitable for wall mounting. The output shall be compatible with the controller it serves. Where manual overrides are indicated, the sensor shall include push button override capability, thermometer or temperature indication, sliding warmer/ cooler mechanism for adjusting the temperature setpoint, and latching cover.

Duct-Mounted Temperature Sensors. Duct-mounted temperature sensors installed in ducts smaller than 10 square feet (0.92 square meters) shall be a single point type. Duct-mounted temperature sensors installed in ducts greater than 10 square feet (0.92 square meters) or subject to temperature stratification shall be averaging type. Sensors shall be a general purpose type with an operating range as needed for the application and an accuracy of ± 1 percent over the full range. The output shall be compatible with the controller it serves.

Pipe Insertion Temperature Sensors. Pipe insertion temperature sensors shall contain a sensing element with an operating range as needed for the application and an accuracy of ± 1 percent over the full range. The sensors shall be installed in brass or stainless steel thermal wells of sufficient size with a minimum insertion length of 2-1/2 inches (65 mm). The output shall be compatible with the controller it serves.

Wall-Mounted Humidity Sensors. Wall-mounted humidity sensors shall be capable of providing continuous measurement of percent relative humidity with an accuracy of ± 5 percent over the range of 10 to 80 percent RH. The assembly shall be installed within a enclosure matching the wall thermostat cover. The output shall be compatible with the controller it serves.

Duct-Mounted Humidity Sensors. Duct-mounted humidity sensors shall be capable of providing continuous measurement of percent relative humidity with an accuracy of ± 3 percent over the range 20 to 90 percent RH. Sensors located outdoors shall be installed in a weather enclosure. The output shall be compatible with the controller it serves.

Pressure Sensors. Pressure sensors shall be suitable for air or water service. Accuracy shall be ± 1 percent of full scale. The unit shall have temperature compensation so that thermal effects are no more than ± 0.5 percent of the full scale from 32 to 100°F. The transmitter shall be suitable for the media and pressure measured.

2.4.04 Temperature Control Panels. Temperature control panels, denoted by the symbol "TCP" and an identifying number, shall be NEMA Type 12 designed for wall mounting and shall be completely prewired and checked. Temperature control panel enclosures shall be manufactured by Hoffman Engineering, Integration Technology Systems Inc, or Par Metal Products Inc.

All controllers, selector relays, switching relays, interlock relays, manual switches, timers, alarm and indicating lights, and other devices indicated to be panel mounted shall be mounted in or on the respective control panel.

Accessories such as indicating lights and selector switches shall be mounted on the hinged front covers of the panels. The accessories and panels shall be identified with an identification plate as described in the Equipment Identification paragraph. The identification plates shall be fastened to the panels with corrosion resistant pan head screws.

Each temperature control panel shall supply power to all associated control system field control components, including but not limited to, damper operators, thermostats, sensors, smoke detectors, and valves. The controls shall include all necessary relays, interlocks, and control devices to enable the control panel to function as described in the sequence of operations on the drawings.

All interconnecting wiring and wiring to terminals for exterior connection shall be stranded copper, insulated for not less than 600 volts, with a moisture and flame-resistant covering rated for at least 90°C. Power distribution wiring on the line side of panel fuses shall be at least 12 AWG. Secondary power distribution wiring, wiring for control circuits, and annunciator and indicating light circuits shall be at least 14 AWG. Wiring shall be color coded in accordance with the color coding legend on the panel wiring diagrams.

<u>Selector Switches</u>. Selector switches shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Selector switches shall be heavy-duty oiltight type with gloved-hand or wing lever operators. Position legends shall be engraved on switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts ac. Contact configuration shall be as indicated on the drawings or as necessary for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty.

<u>Push Buttons</u>. Push buttons shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Push buttons shall be heavy-duty, oiltight type, with legends engraved on the faceplate. Contacts shall be rated 10 amperes continuous at 120 volts ac.

<u>Indicating Lights</u>. Indicating lights shall be Micro Switch "Type PT", Cutler-Hammer "Type T", General Electric "CR", or approved equal. Alarm, indicator, and running status lights shall be furnished with bulbs. Indicating lights shall be heavy-duty, push-to-test, oiltight type with low

voltage bulbs and built-in transformers. Legends shall be engraved on the lens or on a legend faceplate. Bulbs shall be easily replaceable from the front of the device.

Alarm Horns. Alarm horns shall be Federal Signal "Model 350", or approved equal. Alarm horns shall have a sound output of 100 dB at 10 feet (3 m) and shall be rated for 120 volts ac. Horns shall be furnished with mounting hardware suitable for flush mounting.

Relays. Relays shall be Eagle Signal "Series 22, 80"; Potter & Brumfield "Series KRP, CB"; Struthers-Dunn "Series A3, A4", or approved equal. Relays shall be of the plug-in socket base type, with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for alarm input or indicating light service shall have contacts rated at least 3 amperes. Time-delay relays shall have dials or engraved switch settings marked in seconds and shall have timing repeatability of ± 2 percent of setting. Latching and special purpose relays shall be as needed for the specific application.

Terminal Blocks and Panel Wiring. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated, shall be complete with marking strip, covers, and pressure connectors, and shall be labeled to agree with the identification on the temperature control manufacturer's submittal drawings.

Control Power Transformers. Where 24 volt ac control power is necessary for the temperature control components, 120/24 volt transformers shall be furnished and mounted in the respective temperature control panel. Control power transformers shall be sized by the manufacturer based on the equipment load of the panel, shall be copper wound, vacuum impregnated with solid polyester varnish, and shall be 100 percent tested in strict compliance with ANSI, CSA, and UL codes. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded. The control power transformers shall be sized by the manufacturer based on the equipment load of the panel.

Terminals. A terminal shall be provided for each conductor of external circuits, plus one ground cable. At least 8 inches (203 mm) of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. At least 25 percent spare terminals shall be provided.

All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound with nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and shall have a space of at least 40 percent of their depth remaining for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with universal primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surfaces shall be filled before the surface is painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils (100 μm). One quart (0.95 L) of paint shall be furnished with the panels for future touchup painting.

2.4.05 Temperature Indicators.

2.4.05.01 Dial Thermometers. A dial thermometer shall be supplied and installed at each remote bulb sensor for calibration and calibration checks. The range of the dial thermometers shall be -40°F to 120°F (-40°C to 49°C).

In ducted systems containing hydronic coils or electric duct heaters, a dial thermometer shall be furnished and installed on the downstream side of the coil or heater. Thermometers shall be complete with averaging type elements.

2.4.05.02 Electronic Temperature Transmitters. Electronic temperature transmitters shall be furnished to transmit an electronic signal to a controller as indicated in the sequence of operation. The signal shall be compatible with the controller. Sensors shall be calibrated at the temperature control manufacturer's factory. Field adjustable sensors shall be used, with a dial thermometer installed adjacent to each sensor for calibration checks. The sensors shall have a temperature range of at least -20°F to 75°F (-7°C to 24°C).

2.4.06 Smoke Detectors. Smoke detectors, denoted by the symbol "SMD" and an identifying number, shall be System Sensor "DH100", Simplex, Grinnell, or approved equal.

Detectors shall be designed to detect combustion gases, fire, and smoke in air conditioning and ventilating duct systems in compliance with the NFPA 90A and shall contain a detector and air sampling chamber which serves as a reference point to help stabilize the detector against the effects of changes in temperature, humidity, and pressure.

Smoke detectors shall be duct-mounted photoelectric type and shall be completely self-contained, including integral power supply, supervisory and control circuitry and three sets of isolated contacts. The alarm contact shall be spst normally open; the auxiliary alarm contact shall be spdt, and the trouble contact shall be spdt and shall indicate detector malfunction. The alarm and trouble contacts shall be rated 2 amperes at 30 volts dc. The auxiliary alarm contact shall be rated 10 amperes at 120 volts ac. Pilot lights shall be provided for visual indication of alarm and power supply status on the front of the unit. A remote key-operated test station with alarm light and power supply status shall also be furnished and installed where indicated on the drawings. Detectors shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply.

Detectors shall be provided with sampling tubes extending the width of the air duct.

2.4.07 Pressure Differential Switches. The pressure differential switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Initial setpoints shall be as indicated on the drawings. Differential switches shall be UL listed.

Where indicated on the drawings, pressure differential switches shall be provided with an explosionproof housing suitable for a NEC Class 1, Division 2, Group D environment. Where pressure differential switches are located outdoors, a NEMA 4 rated weather enclosure shall be provided.

2.4.07.01 Differential Airflow Switches. Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800", or approved equal.

Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spst, shall be rated 5 amperes at 120 volts ac and for a temperature range of -20°F to 125° F (-29° C to 52°C), and shall be provided with corrosion resistant mounting brackets. Pressure differential switches located across filters shall be initially set at the following setpoints.

Filter Type	Setpoint
1 inch (25 mm) pleated	0.75 inch wc (186 Pa)
2 inch (50 mm) pleated	1.0 inch wc (250 Pa)

Extended Surface 1.2 inch wc (300 Pa)

2.4.07.02 Differential Water Flow Switches. Pressure differential water flow switches shall be Mercoid "Series DP", or approved equal.

Differential pressure switches for water service shall be diaphragm operated by differential pressure. The switches shall be single pole double throw, bellows operated, suitable for 100 psig (690 kPa) working pressure, and shall be rated 15 amperes at 120 volts ac.

2.4.08 Water Flow Switches. Water flow switches, denoted by the symbol "FS" and an identification number, shall be furnished and installed as indicated on the drawings. Switches shall be W.E. Andersen "Model V4-2-U", or approved equal.

Water flow switches shall be spdt, operated by vane motion through a magnetic link. The flow switch body shall be brass with Type 316 stainless steel vane. The flow switch shall be rated for 275°F (135°C) and 150 psig (1034 kPa) service. Piping connection shall be 1-1/2 inch (40 mm) NPT. Switch contacts shall be rated at 5 amperes at 120 volts ac. The water flow switches shall be suitable for mounting in the hydronic system piping as indicated on the drawings.

2.4.09 Control Stations. Control stations for high rate ventilation fans shall include a two position selector switch with nameplate labeled "High Rate Ventilation On/Off". Control stations shall also include two indicating lights for "On/Off" indication. Indicating lights and selector switches shall be heavy duty oiltight NEMA Type 13. The control station enclosure shall be NEMA Type 4. Control stations shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.4.10 Emergency Ventilations Shutoff Switches. Emergency ventilation shutoff switches shall be furnished and installed where indicated on the drawings. The switches shall be Square D, Emergency Break-glass Operator "9001K15", or approved equal. Each break-glass switch for HVAC emergency shutoff shall be furnished with a NEMA Type 4 stainless steel enclosure with hammer, hammer clip, and chain. Each switch shall have one normally open and one normally closed contact block. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position to de-energize the equipment. Nameplates shall be provided as indicated on the on-line diagrams. The switches shall be provided with phenolic nameplates identifying the switches as 'VENTILATION SYSTEM EMERGENCY SHUTOFF."

2.4.11 Control Valves. Modulating control valves shall be sized for a pressure drop of at least 5 psig (35 kPa) and not more than 10 psig (69 kPa) at design flow. Control valves shall be modulating two-way or three-way as indicated in the schedule and on the drawings. Two inch (5.08 cm) and smaller valves shall have bronze bodies and threaded connections. Two and a half inch (6.35 cm) and larger valves shall have cast iron bodies and flanged ends.

Modulating valves shall be equipped with throttling plugs and removable discs and electric actuators or shall be refrigerant pressure actuated as specified herein and as indicated on the drawings. Refrigerant pressure actuated valves shall be suitable for use with the chiller refrigerant.

Modulating electric valve actuators shall be equipped with a proportional, reversing motor which shall produce a linear relationship between valve lift and valve flow at constant pressure drop. Each actuator shall have an internal spdt auxiliary switch rated 5 amperes at 120 volts ac. Actuators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where needed shall be factory wired to the actuator and installed in a NEMA Type 3R enclosure secured to the motor housing.

Valves shall be furnished with linkage bolted directly to the bonnet and motor flange.

2.4.12 Accessory Components. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

2.5 CONSTRUCTION.

2.5.01 Shop Painting. Unless otherwise indicated, shop painting shall be as specified in the General Equipment Stipulations. Surface finish damaged during installation shall be repaired to the satisfaction of the Engineer. Field painting shall conform to the requirements of Master Specification Section 09900, Painting.

2.5.02 Control Circuits. Control wiring shall be in accordance with the National Electrical Code (NEC). Conduit for all HVAC control circuits shall be EMT, except in areas designated on the electrical drawings as Area Type 1A, Area Type 4, or Area Type 12. In areas designated Type 1A conduit shall be exposed rigid PVC non-metallic conduit with PVC fittings, boxes, and accessories. In areas designated Type 4 and Type 12, conduit shall be IMC with gasketed enclosures and fittings. All conduit and conduit installation shall be in accordance with the requirements of Master Specification Section 16050, Electrical General Requirements and the NEC.

2.6 CABLE AND RACEWAYS.

2.6.01 Cable. Cable used in the temperature control system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations. All cable necessary for the system, except 120 volt ac power, shall be furnished by the System Supplier.

2.6.02 Raceways. All cable shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of Master Specification Section 16050, Electrical General Requirements.

2.7 ELECTRICAL. Motor starters and controls shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except for equipment with prewired integral starters. Disconnects for equipment shall be furnished and installed under Master Specification Section 16050, Electrical General Requirements, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical drawings for wiring in conduit. Equipment installed outdoors shall have NEMA Type 4 enclosures. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

Typical schematics on the drawings indicate electrical control items and functions necessary for most of the equipment; however, actual motor sizes shall comply with Master Specification Section 16220, General Purpose Induction Motors.

2.8 SPECIAL TOOLS AND ACCESSORIES. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories needed for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.9 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

PART 3 - EXECUTION

3.1 INSPECTION. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 INSTALLATION. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the drawings. Control equipment shall be installed with adequate operating and maintenance access space.

3.2.01 Temperature Control Panels. The panels shall be mounted so that selector switches and indicating lights on the panel are located approximately 5 feet (1.5 m) above the finished floor.

3.2.02 Thermostats. Wall-mounted thermostats shall be mounted above the finished floors as indicated in Master Specification Section 16050, Electrical General Requirements. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.

Wall-mounted thermostats in nonairconditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3.2.03 Damper Operators. The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position, face dampers shall fail to the closed position, and bypass dampers to the open position.

3.2.04 Device Tag Numbering System. All devices shall be provided with permanent identification tags numbered to agree with the manufacturer's equipment drawings. All field-mounted control devices shall bear securely fastened identification tags. Hand-lettered labels or tape will not be acceptable.

Phenolic nameplates shall be provided and permanently attached to the wall at each control device to indicate the equipment controlled. The letters used shall be the same as the equipment designations indicated herein and on the drawings. Nameplates shall have white letters on black backgrounds.

3.2.05 Control Valves. Three-way hot water valves shall fail open to the heating coil unless otherwise indicated. Three-way chilled water valves shall fail open to the bypass unless otherwise indicated.

3.2.06 Cable. Cable shall be installed in conduit as described in the cable installation paragraphs in Master Specification Section 16050, Electrical General Requirements. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

3.2.07 Raceways. Conduit shall be installed as described in the conduit installation paragraphs in Master Specification Section 16050, Electrical General Requirements.

3.3 FIELD QUALITY CONTROL.

3.3.01 Installation Check. An experienced, competent, and authorized representative of the temperature controls supplier shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3.02 Field Testing. After the installation of the equipment and systems has been completed, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in Master Specification Section 01180, Equipment, Materials, Parts and Tools.

3.4 ADJUSTING. The building system controls supplier shall provide initial startup and adjustment of the control systems, instruction of operating personnel, and set point maintenance for one year.

The building system controls supplier shall be responsible for establishing the final control system settings necessary for proper operation of the equipment and systems. These settings and calibration shall have the concurrence of the equipment manufacturer's representative.

The building system controls supplier shall demonstrate to Owner the complete and correct functioning of all control systems and equipment, and shall make all necessary repairs, replacements, or adjustments to items which fail to perform to the satisfaction of the Owner.

3.5 CLEANING. At the completion of testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to the Owner.

3.6 OPERATOR INSTRUCTION AND TRAINING. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

Documentation in the final Operation and Maintenance Manuals.

Use the Operation and Maintenance Manuals.

Equipment and system startup and shutdown.

System operation procedures for all modes of operation.

Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as needed.

At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

End of Section

SECTION 15990

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SCOPE. This section covers the cleaning, testing, adjusting, and balancing of the air and water systems associated with the heating, ventilating, and air conditioning (HVAC), emergency gas treatment system and odor control systems, as indicated in the Contract Documents.

1.2 GENERAL. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1.2.01 Coordination. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each air or hydronic system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

Hydronic systems shall be complete and operating, with valves, coils, pumps, piping, and control components, and shall be cleaned, filled, and vented. All strainers shall be checked for installation of the appropriate basket and shall be cleaned.

1.2.02 Governing Standards. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air and hydronic systems.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete apparatus report sheets for all air or hydronic systems shall be accurately and completely filled out in accordance with the Standard's manual. Copies of the final test readings and report sheets shall be submitted in accordance with the Master Specification Section 01080, Project

Submittals. As indicated in the Contract Documents, a description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets.

The apparatus report sheets shall include the following information:

1. Title Page:
    a. Company name.
    b. Company address.
    c. Company telephone number.
    d. Project name.
    e. Project location.
    f. Project Engineer.
    g. Project Contractor.
    h. Project altitude.
2. Instrument List:
    a. Instrument.
    b. Manufacturer.
    c. Model.
    d. Serial number.
    e. Range.
    f. Calibration date.
3. Air Moving Equipment:
    a. Location.
    b. Manufacturer.

c. Model.

d. Airflow, specified and actual.

e. Return airflow, specified and actual.

f. Outside airflow, specified and actual.

g. Total static pressure (total external), specified and actual.

h. Inlet pressure.

i. Discharge pressure.

j. Fan RPM.

4. Return Air/Outside Air Data:

a. Identification/location.

b. Design airflow.

c. Actual airflow.

d. Design return airflow.

e. Actual return airflow.

f. Design outside airflow.

g. Actual outside airflow.

h. Return air temperature.

i. Outside air temperature.

j. Required mixed air temperature.

k. Actual mixed air temperature.

l. Design outside/return air ratio.

m. Actual outside/return air ratio.

5. Electric Motors:

a. Manufacturer.

b. HP/BHP.

c. Phase, voltage, amperage; nameplate, actual, no load.

d. RPM.

e. Service factor.

f. Starter size, rating, heater elements.

6. V-Belt Drive:

a. Identification/location.

b. Required driven RPM.

c. Driven sheave, diameter, and RPM.

d. Belt, size, and quantity.

e. Motor sheave, diameter, and RPM.

f. Center to center distance, maximum, minimum, and actual.

7. Duct Traverse:

a. System zone/branch.

b. Duct size.

c. Area.

d. Design velocity.

e. Design airflow.

f. Test velocity.

g. Test airflow.

h. Duct static pressure.

i. Air temperature.

j. Air correction factor.

8. Air Distribution Test Sheet:

a. Air terminal number.

b. Room number/location.

c. Terminal type.

d. Terminal size.

e. Area factor.

f. Design velocity.

g. Design air flow.

h. Test (final) velocity.

i. Test (final) airflow.

j. Percent of design airflow.

9. Air Terminal Unit Data:

a. Manufacturer.

b. Type, constant, variable, single.

c. Identification/number.

d. Location.

e. Model.

f. Size.

g. Minimum static pressure.

h. Minimum design airflow.

i. Maximum design airflow.

j. Maximum actual airflow.

k. Inlet static pressure.

10. Electric Duct Heater:

a. Manufacturer.

b. Identification/number.

c. Location.

d. Model.

e. Design kW.

f. Number of stages.

g. Phase, voltage, amperage.

h. Test voltage (each phase).

i. Test amperage (each phase).

j. Airflow, specified and actual.

k. Temperature rise, specified and actual.

11. Pump Data:

a. Identification/number.

b. Manufacturer.

c. Size/model.

d. Impeller.

e. Service.

f. Design flow rate, pressure drop, BHP.

g. Actual flow rate, pressure drop, BHP.

h. Discharge pressure.

i. Suction pressure.

j. Total operating head pressure.

k. Shut off, discharge and suction pressures.

l. Shut off, total head pressure.

12. Chillers:

a. Identification/number.

b. Manufacturer.

c. Capacity.

d. Model.

e. Evaporator entering water temperature, design and actual.

f. Evaporator leaving water temperature, design and actual.

g. Evaporator pressure drop, design and actual.

h. Evaporator water flow rate, design and actual.

i. Condenser entering water temperature, design and actual.

j. Condenser leaving water temperature, design and actual.

k. Condenser pressure drop, design and actual.

l. Condenser water flow rate, design and actual.

13. Air Cooled Condenser:

a. Identification/number.

b. Location.

c. Manufacturer.

d. Model.

e. Entering DB air temperature, design and actual.

f. Leaving DB air temperature, design and actual.

g. Number of compressors.

14. Heat Exchanger:

a. Identification/number.

b. Location.

c. Service.

d. Manufacturer.

e. Model.

f. Primary water entering temperature, design and actual.

g. Primary water leaving temperature, design and actual.

h. Primary water flow, design and actual.

i. Primary water pressure drop, design and actual.

j. Secondary water entering temperature, design and actual.

k. Secondary water leaving temperature, design and actual.

l. Secondary water flow, design and actual.

m. Secondary water pressure drop, design and actual.

15. Coil Data:

a. Identification/number.

b. Location.

c. Service.

d. Manufacturer.

e. Airflow, design and actual.

f. Entering air DB temperature, design and actual.

g. Entering air WB temperature, design and actual.

h. Leaving air DB temperature, design and actual.

i. Leaving air WB temperature, design and actual.

j. Water flow, design and actual.

k. Water pressure drop, design and actual.

l. Entering water temperature, design and actual.

m. Leaving water temperature, design and actual.

n. Air pressure drop, design and actual.

16. Sound Level Report:

a. Location.

b. Octave bands - equipment off.

c. Octave bands - equipment on.

17. Combustion Test:

a. Boiler manufacturer.

b. Model.

c. Firing rate.

d. Overfire draft.

e. Gas pressure at meter outlet.

f. Gas flow rate.

g. Heat input.

h. Burner manifold gas pressure.

i. Percent carbon monoxide (CO).

j. Percent carbon dioxide (CO_2).

k. Percent oxygen (O_2).

l. Percent excess air.

m. Flue gas temperature at outlet.

n. Ambient temperature.

o. Net stack temperature.

p. Percent stack loss.

q. Percent combustion efficiency.

r. Heat output.

Product data indicating cleaning materials and treatment, chemicals, and reports on the analysis of system water after cleaning and after treatment, shall be submitted in accordance with the Master Specification Section 01080, Project Submittals.

1.4 QUALITY ASSURANCE. Contractor shall provide the services of a licensed independent contractor, certified by AABC or NEBB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air or hydronic systems. The total system balance shall be performed in accordance with AABC, SMACNA, or NEBB Procedural Standards for the work.

1.5 MAINTENANCE. Contractor shall provide the services of a company specializing in water analysis and chemical treatment with at least 3 years of documented experience. The company shall have local representation with water analysis laboratories and full-time service personnel.

The water treatment company shall provide laboratory services and technical assistance for one year from the date of substantial completion of the project. At the completion of the service period, the water treatment company shall conduct a 4 hour training course to instruct facility operating personnel in system maintenance, testing methods, and chemical water treatment procedures.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the Contract Documents.

2.2 CONSTRUCTION.

2.2.01 Painting. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field coatings shall be as specified in Master Specification Section 09900, Painting.

2.3 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual unbalance in each plane of correction shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in punds
N = RPM for N greater than 1,000

PART 3 - EXECUTION

3.1 INSPECTION. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Fire and smoke dampers shall be open and access doors and panels shall be closed during the testing and balancing. A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type	Simulated Loss
1 inch (25 mm) pleated	0.15 inch water column (37 Pa)
2 inch (50 mm) pleated	0.35 inch water column (87 Pa)
Extended surface	0.80 inch water column (200 Pa)

Before starting the hydronic system testing and balancing, all valves and control components shall be opened or set to direct flow through the heat transfer element. The pumps shall be checked for correct rotation and rotative speed.

3.2 STARTUP REQUIREMENTS. System equipment shall be subject to preliminary field tests as indicated.

3.3 FIELD PERFORMANCE TESTING. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
1 inch (25 mm) pleated	0.75 inch water column (186 Pa)
2 inch (50 mm) pleated	1.0 inch water column (250 Pa)
Extended surface	1.2 inch water column (300 Pa)

3.3.01 Hydronic Piping. The hydronic piping systems shall be hydrostatically tested in accordance with ANSI/ASME B31.9.

All equipment or accessories which are connected to the piping systems, and which would be damaged if subjected to the specified test pressure, shall be disconnected and the ends of the branch lines shall be plugged or capped as needed during the testing procedure.

All hydronic piping shall be hydrostatically tested at a test pressure not less than 1.5 times the working pressure, and not less than 50 psi (345 kPa).

3.3.02 Refrigerant Piping. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.

After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.

The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent.

3.4 CLEANING. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3.4.01 Piping. Piping shall be cleaned with a liquid alkaline compound consisting of emulsifying agents and detergents conforming to applicable codes governing the addition of nonpotable chemicals to the buildings' mechanical systems and their discharge to public sewerage systems. All terminal control valves shall be placed in the open position during cleaning. The cleaning agent shall be added to the closed hydronic systems at the concentrations recommended by the cleaner manufacturer.

After piping systems have been cleaned, they shall be flushed with a neutralizing agent recommended by the cleaner manufacturer. All strainer screens in the piping systems shall be removed, cleaned, and replaced.

After the completion of the flushing and neutralizing, the piping systems shall be inspected and any remaining sludge shall be removed. This inspection shall include disassembly of components if necessary.

3.4.01.01 Heating Water System. While the cleaning solution is circulating in the system, it shall be slowly heated to 160°F (71°C) and maintained at that temperature for at least 12 hours. The heating shall then be stopped and the temperature of the circulating solution shall be allowed to drop to 100°F (38°C). The system shall then be drained as rapidly as possible and shall be refilled with clean water. The clean water shall be circulated for 6 hours at design temperatures and then drained. The system shall again be filled with clean water and the procedure repeated until all cleaning solution is removed.

3.4.01.02 Chilled and Condenser Water Systems. The cleaning solution shall be circulated in the system for 48 hours, and then drained as rapidly as possible. The system shall then be filled with clean water, which shall be circulated for 24 hours, and drained. The sequence of rinsing with clean water shall be repeated until all cleaning solution is removed.

3.4.02 Hydronic Systems. After the hydronic system has been cleaned, it shall be filled with clean potable water and immediately treated with the appropriate chemicals. The treatment chemicals shall be suitable for use at the system operating temperature and shall be compatible with the system construction materials of steel, cast iron, stainless steel, and copper alloys.

The water treatment chemicals shall conform to applicable codes governing the addition of nonpotable chemicals to the buildings' mechanical systems and their discharge to public sewerage systems. Sufficient treatment chemicals shall be furnished for the duration of the services period.

Chemical treatment of the hydronic system shall consist of applying corrosion inhibitors, conductivity enhancers, and sequestering agents to reduce deposits and adjust pH.

3.5 ADJUSTING & BALANCING. After completion of the hydronic system chemical treatment, the air and hydronic systems shall be adjusted and balanced.

All instrumentation shall be calibrated within 6 months of use and shall be checked for accuracy before testing, adjusting, and balancing the air and hydronic systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.

All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

3.5.01 Air Systems. Air systems shall be adjusted to the design airflows indicated on the drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not create objectionable air movement or noise.

Dampers with operators shall be checked for tight shutoff when in the closed position.

3.5.02 Hydronic Systems. The hydronic systems shall be adjusted to the design flow rates indicated on the drawings. Equipment or system shutoff valves shall not be used for flow rate adjustment.

End of Section

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DIVISION 16 – ELECTRICAL

SECTION 16050

ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this contract. It also covers conduit, wiring, and terminations for electrical equipment installed under other sections. This section includes:

Power and telephone service entrances
Cable
Conduit
Wiring devices, boxes and fittings
Junction boxes, pull boxes and wiring gutters
Lighting fixtures
Lighting panels
Power panels
Transient voltage surge suppression
Separately enclosed motor starters
Separately enclosed manual starters
Control stations
Separately enclosed circuit breakers
Disconnect switches
Lighting and auxiliary power transformers
Power centers
Power factor correction capacitors
Lighting contactors
Photoelectric controls
Relay enclosures
Alarm horn and beacon
Heat-traced piping
Door entry switches
Drain fittings
Wireways

This section covers the installation of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

When indicated, this section covers installation of equipment furnished by Owner.

The Contractor shall field check and thoroughly get familiarized with the plant field conditions, equipment and devices locations and the plant work environment.

1.2 GENERAL. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

All tags, labels, signs, etc shall be installed by the contractor before work is complete and the equipment turned over to the Owner.

The Contractor must provide “as-built” drawings upon completion of project before final walkthrough.

The responsibility of pulling all permits for work is that of the Contractor, DWSD does not authorize work without all required permits.

Remove all wiring, panels, cabinets, and equipment that is no longer in service or has been left from old contracts and not needed. Verify removal of equipment with Owner and Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.02 Coordination. Electrical work shall conform to the construction schedule and the progress of other trades.

1.2.03 Anchor Bolts and Expansion Anchors. Unless otherwise specified or indicated on the drawings, all anchor bolts, nuts, and washers shall be hot-dip galvanized. Anchor bolts shall be at least 3/4 inch (19 mm) except a smaller size will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

When expansion anchors are indicated on the drawings, only an acceptable expansion anchor shall be used. Alternative anchoring systems may be used only when acceptable to Engineer. Expansion anchors shall be installed in conformity with the manufacturer's recommendations for maximum holding power, but in no case shall the depth of the hole be less than six bolt diameters. The minimum distance between the center of any expansion anchor and an edge or exterior corner of concrete shall be at least six times the diameter of the bolt. Unless otherwise indicated on the drawings, the minimum distance between the centers of expansion anchors shall be at least 12 times the diameter of the bolt.

Nuts and washers for expansion anchors shall be as specified for anchor bolts.

Expansion anchors shall be Hilti "Kwik-Bolt II", ITW Ramset/Red Head "Thrubolt Wedge Anchor", or approved equal.

1.2.04 Drawings. Supplementing this section, the drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

The electrical drawings indicate the general design and extent of the electrical systems. Follow the Drawings as closely as actual construction and the work of other trades will permit.

Examine architectural, mechanical, and other trades' drawings and specifications. Notify the Contracting Officer should any discrepancies occur between them and the electrical work.

Drawings are not intended to be scaled for roughing-in or to serve as shop drawings. Take all field measurements required for fitting the installation to the building.

1.2.05 Maintenance. For all electrical equipment and systems requiring periodic scheduled preventive maintenance, asset number and recommended maintenance procedure data sheet shall be provided for the owner's EMPAC system

1.3 CODES AND PERMITS. All work shall be performed and materials shall be furnished in accordance with the current NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

ANSI	American National Standards Institute.
ASTM	American Society for Testing and Materials.
Fed Spec	Federal Specification.
ICEA	Insulated Cable Engineers Association.
IEEE	Institute of Electrical and Electronics Engineers.
IES	Illuminating Engineering Society.
ISA	Instrument Society of America
JIC	Joint Industrial Council
MDPH	Michigan Department of Public Health

MIOSHA	Michigan Occupational Safety and Health Administration
NBFU	National Board of Fire Underwriters
NECA	National Electrical Contractor's Association
NEMA	National Electrical Manufacturers Association.
NFPA	National Fire Protection Association.
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories.

Equipment covered by this section shall be listed by UL, or by a nationally recognized third party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1.3.01 <u>Changes Required</u>. Notify the Contracting Officer before submitting the proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.

1.3.02 <u>Standards Of Materials And Workmanship</u>. All materials shall be new. The electrical and physical properties of all materials, and the design, performance, characteristics, methods of construction and testing of all items of equipment, shall be in accordance with the latest issue of the various, applicable standard specifications in Paragraph 1.3 and NETA: International Electrical Testing Association

1.3.03 All equipment of the same or similar systems shall be by the same manufacturer.

1.3.04 <u>Resolution of Conflicts</u>. In case of conflicts between codes, reference specifications or drawings, the code, reference specifications or drawings with more stringent requirement shall be used. To use a lesser code or reference, a written permission by the Contracting Officer must be obtained.

1.3.05 <u>Standards</u>. When reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 IDENTIFICATION.

1.4.01 Conduit. Conduits in manholes, handholes and in underground duct banks, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 14 gage (1.63 mm) thick stainless steel, with 1/2 inch (13 mm) stamped letters and numbers as indicated on the drawings. Identification tags shall be attached to conduits with stranded stainless steel tie wraps and shall be positioned to be readily visible.

1.4.02 Cable. Except for lighting and receptacle circuits, each individual wire in power, control, indication, and instrumentation circuits shall be provided with identification markers at the point of termination.

Whenever replacing a 15KV or 5KV cables, the identification tags explained in 1.4.01 shall be at the point of connection and also at the point of termination. If the point of termination being a load break switch, the switch shall be tagged as well, in accordance with the one line diagram of the contract documents. As part of the as-built, the contractor shall also provide terminal to terminal connection drawings for all equipment installed or wired by this contract including the equipment provided by others

The wire markers shall be of the heat-shrinkable tube type, with custom typed identification numbers, or shall be of the self-laminating, write-on type as required.

The wire numbers shall be as indicated on the equipment manufacturer's drawings.

The wire markers shall be positioned to be readily visible for inspection.

Power wires shall be color coded with electrical tape or colored wire jacket; white-N, black, and red for 120/240 volt, 3-wire; and gray-N, brown, orange and yellow for 480/277 volt, 4-wire circuits.

1.4.03 Motor Starters. Motor starters shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the drawings. Nameplates shall have 1/8 inch black baked enamel letters on anodized aluminum plate, and shall be securely fastened to the motor starters.

Motor starters shall be tagged per the identification name assigned in the contract documents. The tags shall be installed on the motor starter housing with three compression bolts. No adhesive tags shall be allowed. Refer to specification section 16075 for more details

1.4.04 Control Stations. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the drawings. . Nameplates shall have 1/8 inch black baked enamel letters on anodized aluminum plate, and shall be securely fastened to the control stations.

1.4.05 Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. . Nameplates shall have 1/8 inch black baked enamel letters on anodized aluminum plate, and shall be securely fastened to the circuit breakers.

Circuit Breakers compartments or cubicles shall be tagged per the identification name assigned in the contract documents. The tags shall be installed on the circuit breaker cubicle or compartment housing with three compression bolts. No adhesive tags shall be allowed. Refer to specification section 16075 for more details. Also label the source of power to the MCC and indicate the individual destination loads from the MCC

1.4.06 Disconnect Switches. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower (kW) rating. An additional nameplate with 1/8 inch black baked enamel letters on anodized aluminum plate, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure. Primary disconnect Switch rated for 5 KV or above provided with CTs, PTs, and local/remote disconnecting means to isolate the main power transformers.

Load Break Switches (15KV & 5KV rated) shall be tagged per the identification name assigned in the contract documents. The tags shall be installed on the switch housing with three compression bolts. No adhesive tags shall be allowed. Refer to specification section 16075 for more details. For the rest of the disconnect switches rated 600V and below, label the source of power to the disconnecting switches and indicate the individual destination loads from the disconnect switches

1.4.07 Nameplates And Directories. Panel directories shall be neatly typed, showing equipment served and location for each breaker or switch with a clear plastic protective cover.

All duplex receptacles shall be identified with the associated panelboard and circuit number.

1.5 SUBMITTALS. Drawings for approval shall be submitted as specified in General Requirements Section 01340 – Shop Drawings, Product Data and Samples.

1.5.01 Submittal Identification. Information covering all materials and equipment shall be submitted for review in accordance with Master Specification Section 01080, Project Submittals. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.

Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.

Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed-referenced with the drawings or specifications.

A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the drawings or specifications.

Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

Transient voltage surge suppressor submittals shall include manufacturer's catalog and specification data, including device dimensions, weight, material composition, and connection diagrams. Documentation shall be provided showing the file number of compliance with UL 1449 listing requirements and results of independent, third party NRTL certification of listed surge ratings. The test results submitted shall include UL file number, date or report, product covered, electrical ratings, voltages, phases, modes of protection, nomenclatures, and UL 1449 ratings with and without disconnect device.

Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the coordination study and the on site testing.

Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

1.5.02 Shop Drawings. Prepare layout shop drawings drawn to scale showing building floor plans and all details of electrical construction, routing of conduits, wiring, grounding, circuiting and related information necessary for the installation and future maintenance of the electrical wiring systems. Shop drawings shall include conduit and wiring schedule showing the number of wires, size of wires, size of conduit, and conduit tag number.

No apparatus or equipment shall be shipped from stock or fabricated until associated shop drawings have been reviewed by the Contracting Officer. By the review of shop drawings, the Contracting Officer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Electrical Contractor of full responsibility for the proper and correct execution of the work required.

Submit shop drawings with all pertinent data and with identification mark number for all equipment, devices and components specified in the specifications or scheduled on the Drawings. Include Cable and Conduit Schedules/Charts as shop drawings for Contracting Officer’s review. The cable and conduit numbering system shall be in accordance with Owner’s Standards. All conduits shall be tagged on stainless steel plate and connected with stainless steel wire. Letters shall be minimum 3/16" high.

Shop drawings shall be reviewed by the Electrical Contractor for completeness and accuracy prior to submitting to the Owner/Contracting Officer for review. The shop drawings shall be dated and signed by the Electrical Contractor prior to submission.

Where the shop drawings consist of manufacturer's standard detail drawings or schedules and contain data for a variety of similar equipment, cross out the not applicable information and indicate the data pertinent to the equipment furnished for this project only. Standard detail drawings and schedules not clearly indicating which data is associated with this Project shall be returned "Rejected - Resubmit".

Where accessories and/or options are specified and do not appear as part of manufacturer's standard detail drawings, state each accessory that is to be provided with the equipment on the standard detail drawings.

Partial submittals of shop drawings for equipment will not be permitted. Where partial submittals are transmitted to the Contracting Officer, they will be returned "Rejected - Resubmit".

Lighting Fixtures shop drawings shall be submitted as one (1) package including all fixtures intended to be used for this project.

Furnish and deliver to the Owner's Representative manuals of all shop drawings when work is completed. See Specification Section 01080 for number of sets and manuals.

Submit manufacturer's shop drawings on all electrical systems and/or equipment to be furnished and installed.

1.5.03 ELECTRICAL CONDUIT AND WIRING SCHEDULE DRAWINGS. Prepare electrical drawings that include conduit and wiring schedules showing the number of wires, sizes of wires, sizes of conduits and conduit tag numbers for approval.

1.5.04 Final Issue Drawings. Revise layout shop drawings as required after construction to indicate the as-built condition.

At the completion of the Project, resubmit to the Owner's Representative the revised Mylars, Electronic Copies (diskettes) and one set of prints for Owner's record.

Submit final project record documents as described in Division 1 Specification 01150.

Approval of shop drawings by Contracting Officer/Owner shall not relieve the Contractor or Supplier of his responsibility for furnishing material and equipment in conformance with the specifications, nor will it invalidate any claim made by the Contracting Officer/Owner because of defective or unsatisfactory material and workmanship.

1.6. PROTECTION AND STORAGE. During construction, the insulation on all electrical equipment insulation shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2.1 POWER AND TELEPHONE SERVICE ENTRANCES. Contractor shall consult the local electric and telephone utilities regarding their service installation requirements, and shall furnish the service equipment in compliance with these requirements.

When required by the power company, power service equipment shall include meter board, meter socket, meter test cabinet, metering transformer cabinet, disconnect means, grounding materials, and riser conduits and service entrance fittings required by the utility and for compliance with codes and regulations.

When required for underground services, trenching and backfill, ducts, service cables, and concrete for duct banks and transformer pads shall be furnished.

When required by the telephone company, telephone service provisions shall include a termination box and an empty conduit from the box to a weatherhead at the point of service. The box shall be NEMA Type 1, galvanized, surface mounted, at least 12 by 18 by 6 inch (300 by 450 by 150 mm) deep, or larger if required. The box shall have a hinged door and an inner mounting board of 3/4 inch (19 mm) exterior plywood, with two coats of varnish.

When required by the telephone company, telephone service provisions shall include one 2 by 4 foot (0.6 by 1.2 m), or 4 by 8 foot (1.2 by 2.4 m) sheet of 3/4 inch (19 mm) exterior plywood mounted on the wall and an empty conduit from the panel installed underground to the point of service.

A weatherhead shall be provided on each service riser conduit.

2.2 CABLE. All cables of each type (such as lighting cable or 600 volt power cable) shall be from the same manufacturer.

All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

Primary power cables shall meet Detroit Edison Standards.

2.2.01 Lighting Cable. When required for lighting circuits, lighting cable (Figure 1-16050 THHN-THWN) shall be provided only in lighting and receptacle circuits operating at 277 volts or less. Lighting and receptacle circuits, 8 AWG (10 mm^2) or larger, shall be as specified for 600 volt (Figure 2-16050 XHHW), (Figure 3-16050 THHN-THWN), or (Figure 13-16050 RHH-RHW-USE) power cable as indicated on the Contract Documents.

Lighting cable shall be manufactured by American Insulated Wire Corp., Rome Cable Corp., or approved equal.

2.2.02 600 Volt Power Cable. When required, cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are permitted, shall be 600 volt (Figure 2-16050 XHHW), (Figure 3-16050 THHN-THWN), or (Figure 13-16050 RHH-RHW-USE) power cable as indicated on the Contract Documents.

600 volt power cable shall be manufactured by The Okonite Co., Prysmain Cable.., or approved equal.

2.2.03 Instrument Cable. When required, cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4-16050 single pair), (Figure 5-16050 single triad), or (Figure 6-16050 multiple pair and/or triad) as indicated on the Contract Documents.

Instrument cable shall be manufactured by Belden Electronic Wire & Cable, Fluorocarbon, Samuel Moore Group, Dekoron Div., or approved equal

2.2.04 Multiconductor Control Cable. When indicated on the drawings as multiconductor, cable in control, indication and alarm circuits shall be multiconductor. Cable shall be (Figure 7-16050 14 AWG THHN-THWN) or (Figure 8-16050 12 AWG THHN-THWN) as required.

Multiconductor control cable shall be manufactured by Belden Electronic Wire & Cable, Fluorocarbon, Samuel Moore Group, Dekoron Div., or approved equal.

2.2.05 Medium Voltage Power Cable. Cable for circuits rated higher than 600 volts but not above 5,000 volts, and for wet or dry locations in conduit and open air, shall be (Figure 9-16050 8 KV EPR) power cable.

2.2.05.01 References

A. Association of Edison Illuminating Companies, Inc. (AEIC)

1. CS5 - Specifications for Polyethylene and Cross-Linked Polyethylene-insulated Shielded Power Cables Rated 5KV through 69KV.
2. CS6 - Specifications for Ethylene Propylene Rubber-insulated Shielded Power Cable Rated 5KV through 69KV.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

1. 48-Test Procedures and Requirements for High-voltage AC Cable Terminations.
2. 404-Cable Joints for Use with Extruded Dielectric Cable and Laminated Dielectric Cable.
3. 592-Standard for Exposed Semiconducting Shields on pre-molded High-voltage Cable Joints and Separable Insulated Connectors.

C. National Electrical Manufacturers Association (NEMA)

1. WC-7 Cross-Linked Thermosetting- Polyethylene Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
2. WC 8 - Ethylene Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

D. National Fire Protection Association (NFPA)

1. 70 - National Electrical Code”

2.2.05.2 System Description

A. Design Requirements

1. Provide medium voltage cable designed and constructed for use under the following service conditions and as per the contract documents:
   a. 13,800, 4,800 or 4,160 volts (line to line), 3 phase, 3 and 4 wire, 60 hertz.
   b. Delta and Wye grounded and ungrounded.
   c. These are underground cables that will be fully submerged in water.

2.2.05.3 Submittals

A. Product Data
   1. Submit manufacturer's technical product data for each type of medium voltage cable and accessory specified and indicated on the contract documents.

2.2.05.4 Products (Shielded Medium Voltage Cable)

A. Manufacturers
   1. The Okonite Co.
   2. Prysmian (previously Pirelli Cable Co.)

B. Cable Description
   1. General
      a. Provide shielded medium voltage cable per AEIC CS6 and NEMA WC 8.
   2. Conductor/s
      a. Three-power conductors, 98 percent conductivity soft drawn bare annealed copper, class B, standard or compacted strand, sized as indicated.
      b. Single-ground conductor, 98 percent conductivity soft drawn bare annealed copper, class B, standard or compacted strand, sized per NFPA 70 for equipment grounding.
   3. Conductor shield
      a. Extruded layer of semi-conducting cross-linked co-polymer thermosetting compound suitable for free-stripping from conductor.
   4. Insulation
      a. Ethylene propylene rubber based thermosetting polymer.
      b. (133) percent insulation level for 5kV & 15kV applications.
      c. Strippable extruded layer of semiconducting cross-linked thermosetting co-polymer compound with cover of bare copper tape, minimum 0.13 mm (five mils) thick, helically applied, 12-1/2 percent overlap or with a cover of concentric serve of annealed solid bare copper wires covered by non-metallic binder tape.
   5. Jacket
      a. Polyvinyl chloride or interlocking metal tape with polyvinyl chloride

jacket.

6. Identification
   a. Print the following information on the cable jacket at maximum 910-mm (36inch) intervals along the entire length:
      1) Manufacturer's name and type.
      2) Conductor size - American wire gauge (AWG) or circular mils(CM).
      3) Conductor material.
      4) Insulation"

Cable for circuits rated higher than 5,000 volts but not above 15,000 volts, and for wet or dry locations in conduit and open air, shall be (Figure 10-16050 15 KV EPR) power cable.

Medium voltage power cable shall be manufactured by BICC Cables Co., The Okonite Co., or approved equal.

2.2.06 Tray Cable. On projects using electrical trays as raceways, cable shall be (Figure 11-16050 3 conductor XLP-PVC) or (Figure 12-16050 single conductor XHHW) tray cable.

Tray cable shall be manufactured by The Okonite Co., Prysmian Cable Corp, or approved equal.

2.2.07 Metal Clad Lighting Cable. Lighting cable (Figure 14-16050 Metal Clad THHN) shall be provided only in lighting and receptacle circuits operating at 277 volts or less, concealed in interior partition walls and above suspended ceilings of finished office and administration areas.

Metal clad lighting cable shall be manufactured by Francis Metals Inc. or approved equal.

2.3 CONDUIT. Conduit and raceways shall be as described in the following paragraphs:

2.3.01 Rigid Steel Conduit. Rigid steel conduit shall be heavy wall, hot-dip galvanized, shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.

Terminations and connections shall be taper threaded and the minimum size shall be ¾ inch (19 mm).

Rigid steel conduit shall be manufactured by Allied Tube and Conduit, Western Tube and Conduit Corp., Wheatland Tube Co., or approved equal.

2.3.02 Intermediate Metal Conduit (IMC). IMC shall be hot-dip galvanized, shall conform to Fed Spec WW-C-581, and shall be manufactured in accordance with UL 1242.

Terminations and connections shall be taper threaded and the minimum size shall be ¾ inch (19 mm).

Intermediate metal conduit shall be manufactured by Allied Tube and Conduit, Western Tube and Conduit Corp., Wheatland Tube Co., or approved equal.

2.3.03 Liquidtight Flexible Metal Conduit. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moistureproof polyvinyl chloride jacket, and shall be UL labeled. The minimum size shall be ¾ inch (19 mm).

Liquidtight flexible metal conduit shall be Anaconda Sealtite, Electri-Flex Liquatite, or approved equal.

2.3.04 Utility (PVC) Duct. Utility duct with concrete encasement shall be polyvinyl chloride (ASTM F-512 designation DB-20) and shall conform to NEMA TC-6 and ASTM F-512.

Utility duct shall be manufactured by Carlon, PWPipe, or approved equal.

2.3.05 Rigid Nonmetallic (PVC) Conduit. PVC conduit shall be heavy wall, Schedule 80, UL labeled for aboveground and underground uses, and shall conform to Fed Spec W-C-1094, NEMATC-2, and UL 651.

Utility duct shall be manufactured by Carlon, PWPipe, or approved equal.

2.3.06 PVC-Coated Rigid Steel Conduit. The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils (1000 μm).

A chemically cured two-part urethane coating, at a nominal 2 mil (50 μm) thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.

Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches (50 mm), whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils (1000 μm).

All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.

PVC coated rigid steel conduit shall be manufactured by Ocal, Perma-Cote, Robroy Industries, or approved equal.

2.3.07 Electrical Metallic Tubing (EMT). EMT shall be hot-dip galvanized, shall be UL approved, and shall conform to Fed Spec WW-C-563 and ANSI C80.3.

Electrical metallic tubing shall be manufactured by Allied Tube and Conduit, Western Tube and Conduit Corp., Wheatland Tube Co., or approved equal.

2.3.08 Rigid Aluminum Conduit (RAC). Rigid aluminum conduit and fittings shall be manufactured of 6063-T1 alloy, shall be UL approved, and shall conform to Fed Spec WW-C-540 and ANSI C80.5.

Rigid aluminum conduit shall be manufactured by Indalex Inc., or approved equal.

2.4 WIRING DEVICES, BOXES, AND FITTINGS. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

2.4.01 Conduit Boxes and Fittings. Galvanized or cadmium plated, threaded, malleable iron, or aluminum when indicated, boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, O Z Gedney, or approved equal.

Rigid PVC device boxes and fittings shall be manufactured by Carlon, Cantex, or approved equal.

Sheet steel device boxes shall be manufactured by Appleton, Raco, Steel City, or approved equal.

PVC coated device boxes shall be manufactured by Ocal, Perma-Cote, Robroy Industries, or approved equal.

Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

2.4.02 Device Plates. Galvanized or cadmium-plated device plates shall be used on surface mounted outlet boxes where weatherproof plates are not indicated.

Device plates on flush mounted outlet boxes where weatherproof plates are not indicated shall be AISI Type 302 stainless steel, Eagle "93nnn series", Hubbell "S series", Leviton "840nn-40 series", or approved equal; nylon or polycarbonate, Eagle "513nV series", Hubbell "Pn series", Leviton "807nn-I series", or approved equal.

Device plate mounting hardware shall be countersunk and finished to match the plate.

Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185", O Z Gedney "FS-1-WSCA", or approved equal.

Device plates for receptacles indicated as weatherproof shall be Appleton "FSK-WRD", Crouse-Hinds "WLRD1", O Z Gedney "FS-1-WDCA, or approved equal.

Flush-mounted, weatherproof plates shall be provided with adapter plates, Appleton "FSK-SBA", Crouse-Hinds "FS031", or approved equal.

Device plates for ground fault interrupter receptacles outdoors or indicated to be weatherproof shall be Appleton "FSK-WGFI", Eagle "966", O Z Gedney "FS-1-GFCA", or approved equal.

Engraved device plates, where indicated, shall be manufactured by Leviton, or equal.

Device plates on PVC conduit fittings shall be Carlon "E98 Series", Cantex "513300 Series", or approved equal.

2.4.03 Wall Switches. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eagle "2221V" through "2224V", Hubbell "HBL 1221I" through "HBL 1224I", Leviton "1221-2I" through "1224-2I", or approved equal.

Switches for pulse control of lighting contactors shall be 15 amperes, 120/277 volts, momentary, double-throw, center "Off", Eagle "1220V", Hubbell "1556I", Leviton "1256-I", or approved equal.

2.4.04 Receptacles. Provide at least one spare receptacle for general building use compatible with each electrical service installed at a DWSD building.

Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eagle "5362V", Hubbell "5362I" or Leviton "5362-I" for 120 volt circuits, and 250 volts, Eagle "5462V", Hubbell "5462I" or Leviton "5462-I" for 240 volt circuits.

Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eagle "647-2V", Hubbell "GF5352I" or Leviton "6899-I".

600 Volt Welding receptacles shall be 30 amperes, 600 volts, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ACRE3034-100", Crouse-Hinds "AR348" plus "ARRC33" and "AR30" or Leviton " 430MI5W". One matching plug, Appleton "ACP3034BC", Crouse-Hinds "APJ3485" or Leviton "430P5W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by the Owner.

240 Volt Welding receptacles shall be 60 amperes, 240 volts, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ACRE6035-150", Crouse-Hinds "AREA6485" or Leviton "460MI9W". One matching plug, Appleton "ACP6034BC", Crouse-Hinds "APJ6485" or Leviton "460P9W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

2.4.05 Special Outlets. Clock outlets shall be Eagle "93632", Hubbell "5235" or Leviton "5261-CH".

2.5 JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel and shall be galvanized after fabrication. Similar enclosures outdoors shall be provided with foam or neoprene gaskets, firmly secured in place, on the hinged doors or removable covers. Box and gutter sizes, metal thickness, and installation details shall comply with the National Electrical Code.

Indoor junction boxes in corrosive areas indicated on the drawings shall be NEMA Type 4X, ABS or stainless steel, manufactured by Hoffman Engineering Co.

Bolt-on junction box covers 3 feet (900 mm) square or larger, or heavier than 25 lbs (11 kg), shall have rigid handles. Covers larger than 3 feet by 4 feet (900 by 1200 mm) shall be split.

Where indicated on the drawings, junction boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be at least Code size, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2.6 LIGHTING FIXTURES. Lighting fixtures shall be furnished as described in the fixture schedule, in accordance with Master Specifications Section 16500, Lighting, and as indicated in the contract documents. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified.

2.6.01 Electronic Ballasts. Electronic ballasts furnished with fluorescent type lighting fixtures shall be CBM certified as meeting requirements of ANSI C82.11 with a THD level of not more than 10 percent.

2.7 LIGHTING PANELS. Unless otherwise specified, each lighting panel shall be a dead-front, 120/240 volt, single phase or 120/208 volt, three phase panelboard with circuit breakers, in accordance with the drawings, Master Specifications Section 16500, Lighting, and the following:

2.7.01 Cabinet. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a hinged trim (cover). Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2.7.02 Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip. Breakers shall have interrupting ratings not less than 10,000 or 22,000 amperes as indicated. Handle clips, to prevent casual operation of breakers, shall be provided for 10 percent (at least two) of the breakers and applied to the circuits as directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the Contract Documents.

2.7.03 Buses. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

Lighting panels shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.8 POWER PANELS. Unless otherwise specified, each power panel, with or without a neutral, shall be dead-front, 3 phase panelboard with circuit breakers, in accordance with the drawings and the following:

2.8.01 Cabinet. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a door with latch and lock. At the completion of the contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2.8.02 Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip type. Breakers up to 240 volts shall have interrupting ratings not less than 10,000, 22,000 or 65,000 amperes. Breakers for 277 volts shall have interrupting ratings not less than 14,000, 25,000 or 65,000 amperes. Breakers for 480 volts shall be rated 600 volts, with interrupting ratings not less than 14,000, 25,000 or 65,000 amperes at 480 volts. Handle clips, to prevent casual operation of breakers, shall be provided for 10 percent (at least two) of the breakers and applied to the circuits as directed.

2.8.03 Buses. The panel shall have 3 phase buses, a neutral bus insulated from the cabinet, and/or a ground bus as indicated. Buses shall be copper, with ampere and voltage ratings and main lugs or breakers as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

Power panels shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.9 TRANSIENT VOLTAGE SURGE SUPPRESSION. Transient voltage surge suppressors (TVSS) shall be provided and installed integral to each lighting panel and power panel assembly. Units shall be UL 1449 listed for installation into motor control centers. TVSS devices shall be designed, manufactured, tested, and installed in accordance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1987.

NEMA LS1-1992 Guidelines.

NFPA 20, 70, 75, and 780.

UL 1449 and 1283.

Each TVSS device shall be configured for permanent connection. In-line, series connected components shall not be acceptable. Each TVSS device shall utilize metal oxide varistors (MOV) connected in parallel.

2.9.01 Device Performance. The minimum surge current capability for each device shall be:

	L-L	L-N	L-G	N-G
Lighting Panels	150,000 A	150,000 A	150,000 A	150,000 A
Power Panels	200,000 A	200,000 A	200,000 A	200,000 A

The minimum UL 1449 rating shall be (inclusive of disconnect):

	L-L	L-N	L-G	N-G
Lighting Panels	330 V	330 V	330 V	330 V
Power Panels	330 V	330 V	330 V	330 V

Each unit shall have a maximum continuous operating voltage (MCOV) greater than 115 percent of the nominal system operating voltage for L-L, L-N, L-G, and N-G.

Each unit shall be capable of suppressing a Category B3 impulse at less than 500 volts. Each unit shall be UL 1283 listed as an electromagnetic interference filter. Electromagnetic filtering shall provide insertion loss with a system noise attenuation of 120 dB from 100 kHz to 100 MHz when tested per 50 Ohm insertion loss method as defined by MIL 220A.

Each unit shall incorporate 200 kAIC rated fusing and shall monitor all modes of protection inclusive of N-G and provide indicator lights (one green and one red LED) on the front cover of the enclosure and an indicator light on each module (inclusive of N-G) to individually monitor each module for failure.

2.9.02 Testing. The Supplier shall provide the following test data for each unit:

Third party testing from a nationally recognized testing laboratory (NRTL) verifying that the total surge current can be passed through the fuse with no charring, flames, or projection of materials. Testing of the fuse only will not be acceptable for this requirement. Testing shall indicate the lowest possible surge that can disrupt the fusing.

Third party, NRTL testing verifying the fault current withstand rating of the fusing employed. Testing shall be conducted in both a high and low impedance fault condition and shall confirm no charring, flaming, or projection of materials.

Life cycle testing per ANSI/IEEE C62.41 and C62.45 with fusing in place for category C3 transients (20 KV at 1.2 x 50 microseconds and 10 KV at 8 x 20 microseconds).

2.10 SEPARATELY ENCLOSED MOTOR STARTERS. Separately enclosed motor starters, unless otherwise specified, shall be full voltage, magnetic, nonreversing and NEMA rated. The starter enclosures shall have NEMA type designations appropriate for the locations where they will be installed. Unless otherwise noted, NEMA Type 4X stainless steel enclosures shall be provided for outdoor locations.

Motor starters shall be manufactured by Cutler Hammer, Square D, or approved equal.

One thermal overload relay shall be provided in each phase lead. Each starter shall be provided with an external, manually reset push button for resetting the thermal overload relays.

Each starter shall include auxiliary contacts as required, plus one spare NO and one spare NC contact.

Contractor shall match the sizes of control power transformers, overload devices, heaters, and starters to the equipment furnished, as they may differ from the values indicated on the drawings. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

All push buttons, selector switches, and lights indicated on the schematics to be provided on or in the starter enclosure shall be heavy-duty, oiltight type. Push buttons on starters located outdoors shall be provided with protective caps.

2.10.01 Three Phase Starters. Three phase starters shall be circuit breaker combination type consisting of 3 phase, 60 Hz contactors with thermal overloads, a 120 volt ac coil, a dry type control power transformer, and a circuit breaker disconnect. Control power transformers shall be sized to handle all simultaneous loads. Starters shall be at least NEMA Size 1 or shall be sized as indicated on the Contract Documents.

Circuit breakers shall be 600 volt magnetic motor circuit protectors for motors smaller than 100 horsepower (75 kW) and 600 volt thermal-magnetic type for 100 horsepower (75 kW) and larger motors. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism.

Three phase starters shall be furnished with external manual breaker operating handles and provisions for up to three padlocks. The access door shall be interlocked with the motor circuit protector, so that the door cannot be opened, except by an interlock override, while the breaker is closed.

The complete 3 phase starter shall have an interrupting rating of at least 14,000, 25,000 or 65,000 amperes at 480 volts as indicated on the Contract Documents.

2.10.02 Single Phase Starters. Single phase starters shall consist of single phase, 60 Hz contactors with thermal overloads and an integral or separately enclosed short-circuit protection device. Starters shall be at least NEMA Size 0, or shall be sized as indicated on the drawings. Integral short-circuit protection devices for single phase starters shall be 120/240 volt, magnetic motor circuit protectors.

Separately enclosed short-circuit protection devices for single phase starters shall be molded-case circuit breakers for motor loads 6 amperes and higher and fused switch disconnects for motor loads lower than 6 amperes. Circuit breaker disconnects shall be 120/240 volt, molded-case, thermal-magnetic circuit breakers. Fused switch disconnects shall have quick-make, quick-break mechanisms and 250 volt, dual-element, time-delay fuses.

The short-circuit protection devices shall have external operating handles capable of being padlocked in the open position, and shall have an interrupting rating of at least 10,000 or 22,000 amperes at 240 volts as indicated.

2.11 SEPARATELY ENCLOSED MANUAL STARTERS. Separately enclosed manual starters not specified elsewhere shall be provided hereunder. Manual starters shall be provided with thermal overload protection properly sized for the motors served and with a contact and overload in each phase lead. Manual starters shall be mounted in NEMA Type 1 enclosures unless otherwise noted.

Manual starters shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.12 CONTROL STATIONS. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall be heavy-duty, oiltight, and shall perform the functions indicated. Indoor control stations shall have NEMA Type 13 enclosures. Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4 stainless steel enclosures with protective caps on the control devices. Control stations in NEC Class I, Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type, Appleton N2 Series, Killark, or approved equal.

2.12.01 Emergency Break-Glass Switch. Each break-glass switch for HVAC emergency shutoff shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Square D "Type 9001K15", Cutler Hammer 10250T Series, or approved equal, with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

2.13 SEPARATELY ENCLOSED CIRCUIT BREAKERS. Circuit breakers shall be 3 pole, 480 volt, molded-case circuit breakers of not less than 14,000, 25,000, or 65,000 amperes interrupting rating at 480 volts ac as indicated, complete with thermal and instantaneous trip elements. Breaker enclosures shall have NEMA designations appropriate for the locations where they will be installed. NEMA Type 4 stainless steel enclosures shall be provided for outdoor locations. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.

Circuit breakers shall have "On", "Off", and "Tripped" indication and padlockable exterior handles.

Circuit breakers shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.14 DISCONNECT SWITCHES. Unless otherwise specified, each disconnect switch shall be 3 pole, nonfusible, 600 volts, with a continuous current rating as indicated on the Contract Documents.

Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed. Switches located outdoors shall have NEMA Type 4 enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of AISI Type 316 stainless steel or of molded reinforced polyester.

Switches shall have high conductivity copper, visible blades; nonteasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.

All switches shall be UL listed and horsepower (kilowatt) rated, and shall meet NEMA KS1-1990. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

Disconnect switches shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.15 LIGHTING AND AUXILIARY POWER TRANSFORMERS. Separately mounted transformers shall be provided in the phases, KVA, and voltages indicated on the Contract Documents. Transformers shall be self-air-cooled, dry type, wall- or floor-mounted, and enclosed for wiring in conduit. Transformers installed outdoors shall be weatherproof. Transformers shall have at least two full capacity voltage taps. Winding for the lighting and auxiliary transformers shall be of copper. Low voltage dry-type transformers shall meet the Energy Policy Act of 2005 minimum efficiency standards.

Transformers shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.16 POWER CENTERS. Power centers shall consist of a primary breaker, a 480-120/240 volt or 480-120/208 volt transformer, a secondary breaker, and a distribution panelboard in a NEMA Type 3R enclosure. Transformer and circuit breaker configuration and ratings shall be as indicated on the Contract Documents.

Power Centers shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.16.01 Transformers. Transformers shall be self-air-cooled, dry type. Transformers shall have at least two full capacity voltage taps.

2.16.02 Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers and provisions for future breakers shall be provided in the quantities, poles, and ampere ratings indicated on the drawings. Breakers shall be single pole, 20 amperes, except as indicated otherwise.

2.17 POWER FACTOR CORRECTION CAPACITORS. Capacitors shall be rated 3 phase delta and for the voltage of the system to which they will be connected. The capacitors shall not contain PCBs. Enclosures shall be suitable for the areas in which they are installed and as indicated by the area designations on the drawings.

The KVAR sizes indicated on the drawings are only approximate and shall be as recommended by the motor manufacturer to improve the power factor to 95 percent at full load. Capacitors shall be complete with discharge resistors and fuses.

Capacitors shall be manufactured by Cutler Hammer, Square D, or approved equal.

2.18 LIGHTING CONTACTORS. Remote control lighting Contactors shall have main and auxiliary contacts as indicated on the drawings. Contactors shall have positive locking features and shall be mechanically held in both positions. Main and auxiliary contacts shall be double-break, continuous-duty rated 20 amperes, 600 volts ac, for all types of loads. Terminals shall accept 18 through 10 AWG conductors. Contactors shall operate in any position and may be manually operated for testing and maintenance.

Contactors shall be Emerson-ASCO 917, Square D Type L and LX (Class 8903), or approved equal.

2.19 PHOTOELECTRIC CONTROLS. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c (11 lux) turnon to 15 ft/c (161 lux) turnoff.

Photoelectric controls shall be manufactured by Intermatic Inc., Tork, or approved equal.

2.20 RELAY ENCLOSURES. Relay enclosures shall be furnished as indicated on the drawings. The enclosure shall have a NEMA designation appropriate for the location where it will be installed. Pilot devices shall be heavy duty, oiltight construction. Relays and timers shall have 120 volt, 60 Hz coils rated for continuous duty in 40°C ambient and 10 ampere, 120 volt ac contacts. Intrinsically safe relays shall be installed within the enclosures in accordance with NEC requirements and shall be Gems "Safe-Pak", B/W "Series 53", or approved equal.

2.21 ALARM HORN AND BEACON. The alarm horns and beacons shall be provided and located as indicated on the drawings. The beacon shall be 120 V ac, strobe light with red lens and acrylic dome, Edwards "Model No. 94C-N5" or Federal Signal "Model 371DST". The alarm horn shall be 120 V ac, weatherproof horn, Edwards "Model No. 876-N5", Federal Signal "Model 350WB", or approved equal.

2.22 HEAT-TRACED PIPING. Outdoor exposed piping shall be heat-traced as indicated on the drawings and as described herein. Heat tracing shall be sized to maintain pipe temperatures at 40°F (4°C) with an outdoor ambient temperature of 0°F (-18°C). Heat tracing shall be of the self-regulating type and shall be suitable for single-phase, 120 volt service. Each run of heat tracing tape shall be provided with a circuit controller, an end-of-line indicating light, junction boxes, mounting accessories, insulation and all other equipment for a complete, properly operating system. The insulation for all heat tracing shall be fiberglass type. Each outdoor installation shall be equipped with an aluminum weatherproof jacket. Each heat-tracing circuit shall be provided with a microprocessor-based circuit controller to monitor temperature and ground fault current. The controller shall be Raychem "DigiTrace 910", Chromalox “IntelliTrace HTLS”, or approved equal. On all plastic pipe equipped with heat tracing, a layer of conducting tape shall be installed prior to installation of the heat tracing.

2.23 DOOR ENTRY SWITCHES. Door entry switches shall be provided as indicated on the drawings and as specified herein. Switches shall be heavy-duty industrial, adjustable, magnetic wide gap type. Switch and magnet housings located in NEC Class I, Division 1 and 2, Group D hazardous areas shall be die-cast aluminum, explosionproof, SimplexGrinnell "Model 2760-9077", Sentrol-Interlogix, or approved equal. Switch and magnet housings located in other areas shall be anodized aluminum, SimplexGrinnell "Model 2760-9082", Sentrol-Interlogix, or approved equal.

2.24 DRAIN FITTINGS. Drain fittings shall be Crouse Hinds type ECD or approved equal.

2.25 WIREWAYS. All wireways shall be NEMA Class 12, enclosed, galvanized 12 gauge steel. Wireways shall be provided with 14 gauge removable covers with captive screws. Wireways shall be sized as shown on the Drawings or as provided by the Engineer.

2.25.01 Acceptable Manufacturers. Wireways shall be as manufactured by Keystone Co., Hoffman, or Square D Co. (type "JIC") or approved equal.

PART 3 - EXECUTION

3.1 COORDINATION STUDY. Contractor shall commission a coordination study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination report as specified in Master Specification Section 16052, Coordiantion Study and Arc Flash Hazard Analysis.

3.2 POWER AND TELEPHONE SERVICE ENTRANCES INSTALLATION. Contractor shall consult the local electric and telephone utilities regarding their service installation requirements, and shall install the service equipment in compliance with these requirements.

Contractor shall coordinate details and timing of service entrance installations with the utilities.

3.3 CABLE INSTALLATION.

3.3.01 General. Except as otherwise specified or indicated on the drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage.

Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may be used for splicing solid cable and for terminations at lighting fixtures.

Splices may be made only at readily accessible locations as allowed by the NEC, but never inside of the conduit bodies.

Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions. All shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be molded rubber type. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Tyco Electronics-Energy (Raychem).

All equipment rated for 4.16 KV and above shall be terminated with stress cones.

Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J", Quote #1823.

Cables operating at more than 3,000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be done with a half-lapped layer of 3M "Scotch 77 Arc-Proofing Tape", anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape" or with equivalent tape by Anixter Brothers or Plymouth/Bishop.

Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or approved equal, woven grips.

Spare cable ends shall be taped, coiled, and identified.

Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.

All cables in one conduit, over 1 foot (305 mm) long, or with any bends, shall be pulled in or out simultaneously.

Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.

3.3.02 Underground Cable Pulling Procedure. Care shall be taken to prevent excessive physical stresses that would cause mechanical damage to cables during pulling. Before pulling cables into the underground duct system and when indicated, Contractor shall submit a pulling procedure for the indicated Circuit Numbers. The procedure shall include the following information:

Point of cable entrance into the duct system.

Point of cable exit from the duct system.

Type of cable grip to be used.

Type of pulling device to be used.

Method of continuously monitoring cable tension during pulling.

Identification of manholes through which cable will be pulled or where splices will be made.

Size and type of cable sheave assemblies to be used.

3.3.03 Cable Insulation Test. Unless otherwise indicated, conductors with insulation rated 5,000 volts and higher shall be given a field dc insulation test.

The ampacity of direct current testing equipment shall be at least 2,500 microamperes.

Final test voltages and the duration of the test shall be as indicated on Figure 9-16050 or 10-16050.

Test procedures shall conform to ICEA S-68-516 (Interim Standard No. 1), Cable Rated 0-35,000 Volts and Having Ozone-Resistant Ethylene-Propylene Rubber Insulation.

The tests shall be performed by experienced personnel specializing in electrical cable testing. Triplicate copies of test data for each cable shall be submitted to Engineer. A Cable Test Data Form is included on Figure 15-16050.

3.4 CONDUIT INSTALLATION. Except as otherwise specified or indicated on the drawings, conduit installation and identification shall be done according to the following procedures. A pulling string shall be left inside of every conduit, and accessible at every junction box and panel.

3.4.01 Installation of Interior and Exposed Exterior Conduit. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the drawings. No conduit shall be exposed in water chambers unless so indicated on the drawings.

Unless otherwise indicated on the drawings, Contractor shall be responsible for routing the conduit to meet these installation requirements.

Conduit installed in all exposed indoor locations, except corrosive areas indicated on the drawings, and in floor slabs, walls, and ceilings of hazardous (classified) locations, shall be rigid steel or intermediate metal. Exposed conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid PVC Schedule 80.

Conduit installed in all exposed outdoor locations shall be PVC-coated rigid steel, rigidly supported by PVC-coated mounting hardware and framing materials. Nuts and bolts shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquidtight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet (1.8 m) unless otherwise acceptable to Engineer.

Terminations and connections of rigid steel and intermediate metal conduit shall be taper threaded. Conduits shall be reamed free of burrs and shall be terminated with conduit bushings.

Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

Two or more conduits in the same general routing shall be parallel, with symmetrical bends.

Conduits shall be at least 6 inches (150 mm) from high temperature piping, ducts, and flues.

Rigid PVC Schedule 80 conduit shall have supports and provisions for expansion as required by NEC Article 347.

Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.

Rigid PVC Schedule 80 conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.

Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement.

Conduits that cross structural joints where structural movement is allowed shall be fitted with concrete tight and watertight expansion/ deflection couplings, suitable for use with metallic conduits and rigid PVC Schedule 80 conduits. The couplings shall be Appleton type DF, Crouse-Hinds type XD, OZ/Gedney type DX, or approved equal.

Conduit shall be clear of structural openings and indicated future openings.

Conduits through roofs or metal walls shall be flashed and sealed watertight with approved sealant.

Conduit installed through any openings cut into concrete or masonry structures shall be neatly grouted with approved grout and sealant.

Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

Exposed steel conduit stubs for future use shall be terminated with galvanized pipe caps.

Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

Where the drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

Horizontal conduit shall be installed to allow at least 7 feet (2.1 m) of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.

PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.

All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

Nonmetallic conduit, which turns out of concrete slabs or walls shall be connected to a 90 degree elbow of metallic conduit before it emerges.

Conduits that turn out of concrete floor slabs shall be given a heavy coat of coal tar paint extending 2 inches (50 mm) on each side of the point of turn-out, or a three lap wrap of 4 inch (100 mm) wide 3M Company 51 tape applied over a coat of 3M No. 34548 primer.

Conduit for Heliax type foam dielectric coaxial cable shall be installed as follows:

Heliax Size inches (mm)	Minimum Conduit Size inches (mm)	Minimum Conduit Bend Radius inches (mm)
1/2 (13)	1-1/2 (40)	10 (250)
7/8 (22)	2 (50)	18 (450)
1-1/4 (32)	4 (100)	22 (550)
1-5/8 (42)	4 (100)	28 (700)

Power conductors to and from adjustable frequency drives shall be installed in steel conduit.

3.4.02 Underground Conduit Installation. All excavation, backfilling, and concrete work shall conform to the respective sections of these specifications. Underground conduit shall conform to the following requirements.

All underground conduits shall be concrete encased unless indicated otherwise on the drawings. Concrete encasement installed under roadways shall be reinforced as indicated on the drawings.

Concrete encased conduit shall be rigid schedule 80 (PVC) conduit or PVC utility duct as indicated on the Contract Documents. Conduits shall have end bells where terminated at walls. All joints shall be solvent welded in accordance with the recommendations of the manufacturer.

Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches (150 mm) above grade, with top crowned and edges chamfered.

Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches (50 mm) from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch (45 by 20 mm) deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.

Underground conduits indicated not to be concrete encased shall be rigid Schedule 80 PVC.

Underground conduit bend radius shall be at least 2 feet (600 mm) at vertical risers and at least 3 feet (900 mm) elsewhere.

Underground conduits and conduit banks shall have at least 2 feet (600 mm) of earth cover, except where indicated otherwise.

Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in Master Specification Section 03300, Cast-in-Place Concrete.

Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90 degree elbows of PVC-coated rigid steel conduit before they emerge.

Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

Underground conduits shall be sloped to drain from buildings to manholes.

Each 5 KV or higher voltage cable, each 250 kcmil (120 mm^2) or larger cable, and each conduit group of smaller cables shall be supported from manhole walls by Kindorf "D-990" or Unistrut "P-3259" inserts, with Kindorf "F-721-24" or Unistrut "P-2544" brackets and Unistrut "P1753" or "P1754" fiberglass reinforced polyester cable saddles.

Telephone cables shall not be installed in raceways, conduits, boxes, manholes, or handholes containing other types of circuits.

Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.

3.4.03 Sealing of Conduits. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch (25 mm) and larger conduit connections to equipment.

Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU", Crouse-Hinds "EYS", or approved equal sealing fittings with sealing compound.

3.4.04 Reuse of Existing Conduits. Existing conduits may be reused subject to the concurrence of Engineer and compliance with these requirements.

A wire brush shall be pulled through the conduit to remove any loose debris and a mandrel shall be pulled through the conduit to remove sharp edges and burrs.

3.5 WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

3.5.01 Conduit Boxes and Fittings. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.

Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.

Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

Telephone conduit shall be provided with separate junction boxes and pull fittings.

3.5.02 Device Plates. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

3.5.03 Wall Switches. Wall switches shall be mounted 3'-6" (1.05 m) above floor or grade.

After circuits are energized, all wall switches shall be tested for proper operation.

3.5.04 Receptacles. Convenience outlets shall be 18 inches (450 mm) above the floor unless otherwise indicated.

Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet (1.2 m) above floor or grade.

Welding receptacles shall be surface-mounted 4 feet (1.2 m) above the floor.

After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.

3.5.05 Special Outlets. Wall thermostats shall be 4'-6" (1.35 m) above the floor unless otherwise indicated. Thermostats on exterior walls shall be suitably insulated from wall temperature.

Telephone outlets shall be 18 inches (450 mm) above the floor unless otherwise indicated. Telephone outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet (1.2 m) above floor or grade.

Clock outlets shall be located 7 feet (2.1 m) above the floor.

3.6 EQUIPMENT INSTALLATION. Except as otherwise specified or indicated on the drawings, the following procedures shall be used in performing electrical work.

3.6.01 Setting of Equipment. All equipment shall be installed level and plumb. Sheet metal junction boxes, equipment enclosures, sheet metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch (6 mm) thick corrosion-resistant spacers.

3.6.02 Sealing of Equipment. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795", General Electric "SCS1200", or approved equal.

3.7 GROUNDING. The electrical system and equipment shall be grounded in compliance with the NFPA National Electrical Code and these requirements.

All ground conductors shall be at least 12 AWG (4 mm^2) soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

Ground cable splices and joints, which will be inaccessible after completion of construction, shall meet the requirements of IEEE 837, and shall be Cadweld "Exothermic", Burndy "Hyground", or approved equal.

Ground cable through exterior building walls shall enter within 3 feet (900 mm) below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch (300 mm) copper disc over the cable.

Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 6 inches (150 mm).

Lighting fixtures and receptacles shall be grounded by a copper ground conductor in addition to the conduit connection.

Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with clamp type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.

The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

Ground conductors on equipment shall be formed to the contour of the equipment and firmly supported.

Ground rods not described elsewhere shall be 3/4 inch (19 mm) in diameter by 10 feet (3 m) long, with a copper jacket bonded to a steel core.

Inspect grounding and bonding system conductors and connections for tightness and proper installation.

Ground Resistance Test: Use a ground resistance test instrument for ground resistance testing. Perform testing in accordance with test instrument manufacturer’s instructions. Perform test in normally dry weather, not less than 48 hours after rainfall. Resistance shall be 3 ohms or less to pass.

3.8 <u>LIGHTING FIXTURE INSTALLATION</u>. Installation of lighting fixtures shall be as specified in Master Specifications Section 16500, Lighting.

3.9 <u>POWER FACTOR CORRECTION CAPACITOR INSTALLATION</u>. Capacitors shall be furnished and installed for the motors indicated on the drawings. Capacitors shall not be connected to the load side of solid-state starters, reduced-voltage autotransformer starters with open transition, multi-speed starters, or adjustable frequency drives. Galvanized angle iron mounting stands shall be furnished for mounting the capacitors at least 4 inches (100 mm) above the mounting surface.

3.10 <u>MODIFICATIONS TO EXISTING EQUIPMENT</u>. Modifications to existing equipment shall be completed as indicated on the Contract Documents. All existing facilities shall be kept in service during construction. Temporary power or relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as indicated on the Contract Documents. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.

3.10.01 Demolition. Unless otherwise specified or indicated on the drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed, and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Contract Documents.

End of Section

SECTION 16052

COORDINATION STUDY AND ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SCOPE. This section specifies the Contract requirements for conducting and implementing plant-wide arc flash as well as short circuit and coordination studies. The arc flash study is to include all equipment over all voltage levels throughout the plant, including emergency generators and new equipment added under this Contract. Similarly, the short circuit and coordination study is to include the entire existing electrical system and all new electrical systems added under this Contract.

1.2 GENERAL. Information for Bidders, is made available for Contractor use in conducting Work specified herein. Contractor is responsible for field-verifying all information used in conducting the studies and implementing all study results.

1.3 COORDINATION. Contractor is responsible for conducting and carrying out all Work specified in accordance with the requirements of Master Specification Section 01070, Project Coordination and Meetings. Additionally, Contractor shall incorporate Work specified herein with the requirements of Master Specification Section 01060, Quality Control. In carrying out the implementation of the study recommendations, all Work must be completed as specified in Master Specification Sections 16050, Electrical General Requirements, and 01180, Equipment, Materials, Parts, and Tools. All necessary training shall be carried out per Master Specification Section 01160, Training and Operations and Maintenance Manuals.

1.4 SUBMITTALS. Study reports generated under this section shall be submitted for review in accordance with the requirements of Master Specification Section 01080, Project Submittals. Reports shall meet the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SHORT CIRCUIT AND COORDINATION STUDY. A Coordination Study shall be prepared detailing electrical system protection, protective equipment selectivity and arc flash hazard analysis studies. As minimum, the report shall include the following sections:

1.5.01 One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations.

1.5.02 Descriptions, purpose, basis and scope of the study.

1.5.03 Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.). The short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings.

1.5.04 Protective device time versus current coordination curves with associated one-line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings.

1.5.05 Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout.

1.5.06 Incident energy and flash protection boundary calculations.

1.5.07 Comments and recommendations for system improvements, where needed.

1.5.08 Executive Summary including source of information and assumptions made.

1.6 COORDINATION AND ARC FLASH HAZARD STUDY

1.6.01 Include as part of Contract a complete Coordination and Short Circuit Study and arc flash hazard study from incoming power lines through the high voltage switchgear, unit substations, and the motor control center branch circuits. Obtain available short circuit current, inrush current, and upstream protective device time current curves from the power company. Include power company current data and protective device curve as part of study. Study shall include all coordinating curves with each fuse size, trip settings, and thermal overloads given for connected loads. Curves shall include feeder wire melting curves and transformer ANSI rating points. The study shall also include variable frequency drives for motors larger than 40 Hp, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators, associated paralleling equipment and distribution switchgear. Fuse sizes on motor control centers shall be those shown in Drawings throughout the short circuit and coordination study. Changes in loads from those shown on Drawings shall be incorporated in Study.

1.6.02 Contractor shall furnish all field data as required for the power system studies and arc flash hazard analysis studies. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

1.6.03 Studies shall be performed by an independent engineering specialty firm, subject to the approval of the Engineer. Study results shall be submitted to Engineer for approval.

Short circuit, and protective device coordination and motor starting studies shall be performed on nationally recognized computer software such as SKM System Analysis, Paladin Design Base (formally EDSA), ETAP, or approved equal.

1.6.04 After approval, electrical equipment settings, thermal overloads, and fuses for equipment installed as part of this project shall be made to conform to approved results. Contractor shall test all trip settings, time delays, and indicating devices on all switchgear, unit substations, and motor control centers installed as part of this project. Tests shall be witnessed by Engineer. A list of recommended fuse sizes, overloads and settings conforming to approved results, shall be provided for all fuses, thermal overloads, and electrical settings of equipment and loads included as part of the power system coordination study and arc flash hazard analysis study.

1.6.05 Data sheets for the testing are to be furnished by Contractor and shall be filled out showing the desired settings from Coordination Study and results obtained from witnessed test. Data sheets shall be signed by those performing test and the test witness. Test data sheets and motor list showing fuses, thermal overload sizes, etc. shall be submitted to Engineer as part of Contract.

1.7 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

1.7.01 Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

1.7.02 Provide the following information in the study report:

Calculation methods and assumptions.

Base per unit quantities.

One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted.

Source impedance data, including electric utility system and motor fault contribution characteristics.

Typical calculations and tabulations of calculated quantities.

Results, conclusions, and recommendations.

1.7.03 Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

Electric utility's supply termination point.

Incoming switchgear.

Unit substation primary and secondary terminals.

Low voltage switchgear.

Motor control centers.

Standby generators and automatic transfer switches.

Branch circuit panelboards.

Other significant locations throughout the system.

1.7.04 On grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

1.7.05 Protective Device Evaluation:

Evaluate equipment and protective devices and compare to short circuit ratings.

Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses.

Adequacy of transformer windings to withstand short-circuit stresses.

Cable and busway sizes for ability to withstand short-circuit heating.

Notify Owner in writing, of existing circuit protective devices improperly rated for the calculated available fault current.

1.8 PROTECTIVE DEVICE COORDINATION STUDY

1.8.01 Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

1.8.02 Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

1.8.03 Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

1.8.04 Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

1.8.05 Plot the following characteristics on the curve sheets, where applicable:

Electric utility's protective device.

Medium voltage equipment relays.

Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.

Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters.

Conductor damage curves.

Ground fault protective devices, as applicable.

Pertinent motor starting characteristics and motor damage points.

Pertinent generator short-circuit decrement curve and generator damage point.

Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center.

1.8.06 Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

1.9 ARC FLASH HAZARD ANALYSIS

1.9.01 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

1.9.02 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model.

1.9.03 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

1.9.04 The Arc-Flash Hazard Analysis shall include all medium voltage and 480v locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

1.9.05 Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

1.9.06 The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume arcing impedances which limit fault values to 33 percent of three phase bolted fault values. Medium voltage calculations shall use values over 38 percent as recommended in IEEE 1584-2002. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

1.9.07 Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

1.9.08 Arc Flash calculations shall be based on actual over current protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

1.10 REPORT SECTIONS

1.10.01 Input Data:

Utility three-phase and line-to-ground available contribution with associated X/R ratios.

Short-circuit reactance of rotating machines with associated X/R ratios.

Cable type, construction, size, # per phase, length, impedance and conduit type.

Bus duct type, size, length, and impedance.

Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio.

Reactor inductance and continuous ampere rating.

Aerial line type, construction, conductor spacing, size, # per phase, and length.

1.10.02 Short-Circuit Data:

Source fault impedance and generator contributions.

X to R ratios.

Asymmetry factors.

Motor contributions.

Short circuit kVA.

Symmetrical and asymmetrical fault currents.

1.10.03 Recommended Protective Device Settings:

Phase and Ground Relays:

Current transformer ratio.

Current setting.

Time setting.

Instantaneous setting.

Specialty non-overcurrent device settings.

Recommendations on improved relaying systems, if applicable.

Circuit Breakers:

Adjustable pickups and time delays (long time, short time, ground).
Adjustable time-current characteristic.

Adjustable instantaneous pickup.

Recommendations on improved trip systems, if applicable.

1.10.04 Incident energy and flash protection boundary calculations.

Arcing fault magnitude.

Device clearing time.

Duration of arc.

Arc flash boundary.

Working distance.

Incident energy.

Hazard Risk Category.

Recommendations for arc flash energy reduction

PART 2 - PRODUCTS

NOT USED

PART 3 – EXECUTION

3.1 ARC FLASH WARNING LABELS

3.1.01 The CONTRACTOR shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

3.1.02 The label shall have an orange header with the wording, “WARNING, ARC FLASH HAZARD”. For locations where arc flash energy at working boundary exceeds 40 cal/cm^2 label shall have a red header with the wording, “WARNING, ARC FLASH HAZARD”. Labels shall include the following information:

Location designation

Nominal voltage

Flash protection boundary

Hazard risk category

Incident energy at working distance

Working distance

DWSD Project Number

Engineering report number, revision number and issue date.

3.1.03 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended over current device settings.

For each 600, 480 and applicable 208 volt panel boards and disconnects, one arc flash label shall be provided.

For each motor control center, up to four arc flash labels shall be provided, one at each main breaker, and one at each end of the motor control center.

For each low voltage switchboard, one arc flash label shall be provided.

For each switchgear or unit substations, up to four arc flash labels shall be provided, one at each main breaker, and one at each end of the equipment.

For each medium voltage switch, one arc flash label shall be provided.

3.1.04 Labels shall be field installed by the independent engineering specialty firm during the Startup and Acceptance Testing.

3.2 <u>ARC FLASH TRAINING</u>

3.2.01 The Contractor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum three (3) sessions, each comprised of four (4) hours for eight (8) trainees). Contractor shall provide all materials necessary for conducting the training. Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

End of Section

SECTION 16150

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE. This section covers pulse width modulated (PWM) type variable frequency drives (VFD) for the equipment and locations as indicated on the drawings or as specified in other sections.

VFD's shall be designated and shall be located as required.

1.2 GENERAL. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Equipment provided under this section shall be fabricated as specified in this section and as shown on the schematics and one line diagrams on the Contract Drawings.

Unless otherwise indicated on the drawings, one variable frequency drive, complete with all required control components, shall be furnished for each motor.

VFD’s shall be manufactured/assembled in their entirety at the manufacturer's factory. Systems fabricated or assembled in whole or in part by parties other than the drive manufacturer will not be acceptable.

Motors shall be compatible with the VFD’s.

1.2.01 Coordination. The design of the variable frequency drive shall be coordinated with the driven equipment. Unless otherwise indicated, the manufacturer of the driven equipment shall be responsible for furnishing the variable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design effort to limit harmonics to the levels specified.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.03 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. Contractor shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1.2.04 Workmanship and Materials. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.05 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
AWG	American Wire Gage
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.2.06 Governing Standards. The variable frequency drive shall be designed, constructed, and tested in accordance with the applicable standards of NEMA, ANSI, UL, and IEEE, and shall be designed for installation in accordance with the NEC. The drives shall be UL or ETL listed.

1.2.07 Nameplates. All devices mounted on the face of the drive shall be provided with suitable nameplates. Nameplates shall have 1/8 inch black baked enamel letters on anodized aluminum plate. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate. All other devices shall have a nameplate with black baked enamel letters on anodized aluminum plate.

1.3 DESCRIPTION. The VFD shall produce a variable ac voltage/frequency output and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

1.3.01 Six-Pulse Drives. Each drive, for motors rated below 100 horsepower, shall be of the pulse-width modulated type and shall consist of a full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

The drive inverter output shall be generated by insulated gate bipolar transistors (IGBT) that shall be controlled by six identical base driver circuits. The drive shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1.3.02 Eighteen-Pulse Drives. Unless otherwise indicated, each drive, for motors rated 100 horsepower and above, shall be of the pulse-width modulated type and shall consist of an 18-pulse, full-wave diode or gated-open SCR bridge. The rectifier shall convert incoming fixed voltage and fixed frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor that generates a sine-coded output voltage.

The phase shifting transformer required to produce the phase shifted input to the 18-pulse rectifier shall be factory wired and mounted within the drive enclosure as an integral part of the drive assembly. External transformers shall not be required.

The VFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) that shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

1.4 SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor control center shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data shall include, but shall not be limited to, the following:

Name of manufacturer.

Types and model numbers.

Rated drive input kVA and output kVA.

Percent efficiency at 100 percent speed and 60 percent speed.

Maximum Btu (kJ) heat release data and verification of the drive cooling requirements.

Total weight and lifting instructions, height, mounting, and floor space required.

Panel interior and front and side exterior view details showing maximum overall dimensions of all transformer, bypass contactor, ac line filter, ac line reactor, and drive compartments.

Schematics, including all interlocks.

Wiring diagrams, including all internal and external devices and terminal blocks.

Locations and sizes of electrical connections, ground terminations, and shielded wires.

List of diagnostic indicators.

List of fault and failure conditions that the drive can recognize and indicate for simultaneous occurrence.

List of standard features and options.

List of spare parts to be furnished.

Unless furnished under another section, submit harmonic calculations by the drive manufacturer at the points of common coupling. Detailed drawings and information showing how protection is applied to comply with harmonic limits.

Input line protection model numbers and manufacturer's data sheets.

Output filter model number and manufacturer's data sheets.

Certification of conformal coating on all printed circuit boards.

Unless this testing plan is furnished under another section, submit a detailed harmonic testing plan. The test plan should include instruments to be used, verification of testing locations for voltage and current harmonic metering, verification of maximum allowable voltage and current distortion, and drive load and speed test parameters.

1.5 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Manufacturer's operation and maintenance manual for each size of variable frequency drive.

Manufacturer's standard manuals for each size and type of bypass contactor, transformer, line reactor, and filter.

Schematics, wiring diagrams, and panel drawings in conformance with construction record.

Model numbers and up-to-date cost data for spare parts.

Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.

Connection data to permit removal and installation of recommended smallest field-replaceable parts.

Information on testing of power supplies and printed circuit boards and an explanation of the drive diagnostics.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.6 <u>SHIPPING, STORAGE, AND HANDLING</u>. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Each item of equipment shall be tagged or marked as required. Complete packing lists and bills of material shall be included with each shipment.

1.7 <u>SPARE PARTS</u>. The drive manufacturer shall provide spare parts for each type and size of drive supplied. The spare parts shall include at least one complete set of all plug-in components, including printed circuit boards and control boards, for each size and type of drive, and shall also include the following:

Power fuses

Control fuses

Indicating lights

Rectifier power semiconductors

Inverter power semiconductors

One of each type printed circuit board and gate firing board

Other field-replaceable component parts

Spare parts shall be suitably packaged, labeled, and delivered as specified in Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. All drives shall be pulse-width modulated type, as manufactured by ABB, Allen Bradley, Cutler Hammer, Siemens, Square "D", or approved equal.

All variable frequency drives shall be a product of the same manufacturer.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

2.2.01 Performance. The variable frequency drive controller shall be of sufficient capacity and shall produce a quality output waveform for stepless motor control from 10 to 100 percent of base speed. The variable frequency drive shall be suitable for either constant torque (CT) or variable torque (VT) loads as required by the driver's equipment. The variable frequency drive shall meet the following ratings and parameters:

Input voltage and frequency	460 volts (±10 percent) unless otherwise indicated; 3 phase, 60 Hz (±2 Hz); imbalance, 2 percent maximum.
	Continued operation with additional momentary 25 percent voltage dip of 0.5 second duration from nominal input voltage level.
Minimum drive efficiency	95 percent at 100 percent speed, 90 percent at 60 percent speed.

Ambient temperature	15°F to 105°F (-10°C to 40°C).
Relative Humidity	0 to 95 percent non-condensing.
Displacement Power Factor	95 percent or higher throughout the entire operating speed range, measured at drive input terminals.
Drive service factor	1.15.
Over current capability	110 percent for 1 minute for variable torque; 150 percent for 1 minute for constant torque.
Volts/Hz ratio	Voltage varies as the square of frequency over the entire range of the unit for variable torque drives, constant over the entire range of the unit for constant torque drives; except under voltage boost condition.
Acceleration/deceleration time	Variable over a range that meets the requirements of the drive equipment.
Output speed regulation	0.5 percent.
Output frequency stability	0.5 percent of nominal.

2.2.02 Adjustments. The following drive adjustments shall be provided:

Maximum speed.

Minimum speed.

Linear acceleration time.

Linear deceleration time.

Volts/Hz ratio; linear, squared, and automatic settings.

Voltage boost.

Process follower gain, offset, and bias.

Torque limit.

Critical frequency avoidance with variable bandwidth.

2.2.03 Fault Protection. Design of the power circuit shall include provisions for protection against fault conditions as follows.

2.2.03.01 Input Protection.

High speed current limiting fuses rated 200,000 AIC, specifically designed for solid state applications.

Solid state instantaneous overcurrent trip set at 180 percent.

Variable over voltage and under voltage protection with automatic restart.

Phase loss and reverse phase trip with manual restart.

2.2.03.02 Internal Protection.

AC line, phase-to-phase transient voltage surge suppression utilizing metal oxide varistors. Drive shall meet the requirements of IEEE C62.41.

Power device snubbers.

Power devices rated 2.5 times line voltage.

Instantaneous overcurrent.

Static overspeed (overfrequency) protection.

DC bus over voltage trip.

DC bus discharge circuit with an indicator lamp, for protection of personnel.

Individual transistor overtemperature and overcurrent protection.

Control logic circuit malfunction indication.

2.2.03.03 Output Protection.

Inverse-time motor overload protection variable from 10 percent to 100 percent.

Overvoltage protection.

Overfrequency protection.

Short circuit protection (three phase, phase to phase, and ground fault protection).

Protection against opening or shorting of motor leads.

Static overspeed protection.

Stall protection on overload with inverse time Over current trip, variable current limit from 10 percent to 120 percent.

2.2.04 Harmonic Distortion Abatement. The electrical system shall be provided with the necessary equipment to protect the drive and the power system ahead of the drive from harmonic distortion, as described below.

The drive shall operate satisfactorily when connected to a bus supplying other solid-state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt-microseconds.

Harmonic distortion abatement equipment shall be provided to bring the facility and its electrical system into compliance with IEEE 519, 1992 at the points of analysis defined below and indicated on the Contract Drawings. The supplier shall review the existing facility loads and shall take note of the equipment – as indicated in the Contract documents. All distortion reports and/or testing shall include the existing facility loads. The maximum total harmonic distortion (THD and TDD) allowed at the points of analysis shall include harmonics from the existing equipment as well as the harmonics from equipment provided under this section.

2.2.04.01 Current Distortion Limits. Maximum allowable total and individual harmonic current distortion limits for each odd harmonic shall not exceed limits set forth in IEEE 519, 1992. The power company connection shall be the primary point of analysis for current distortion. The values of utility short circuit current at the utility interface and the total maximum running amperes of all equipment powered from the utility connection shall be as indicated on the drawings.

2.2.04.02 Voltage Distortion Limits. Individual or simultaneous operation of the drives shall result in a maximum total harmonic voltage distortion of 5 percent on the bus feeding the drives. Individual or simultaneous operation of the drives shall not add more than 10 percent total harmonic voltage distortion to the bus feeding the drives while operating from a standby generator. The point(s) of analysis for harmonic voltage distortion testing shall be the nearest electrical bus on the supply side of each drive. The three phase fault current at the bus feeding the drives is as indicated on the drawings.

2.3 CONSTRUCTION.

2.3.01 Fabrication and Assembly. The variable frequency drive system shall be shop assembled in a single enclosure using interchangeable plug-in printed circuit boards and power conversion components wherever possible. Shop assembly shall be performed by the drive manufacturer; systems fabricated or assembled in whole or in part by parties other than the drive manufacturer will not be acceptable. Changes to the drive manufacturer's product by a distributor or system integrator are not allowed.

Input line reactors, fuses, circuit breakers, and filters, where required, shall be mounted within the drive enclosure, without exception. Isolation/voltage matching transformers, where required, may be enclosed separately from the remaining drive equipment.

2.3.02 Wiring. Internal cabinet wiring shall be neatly installed in wireways or with wire ties where wireways are not practical. If wire ties are used, the wire bundles shall be held at the back panel with a screw-mounted mounting base. Bases with a self-sticking back are not acceptable.

Power entry and exit for the drive shall be through the top or bottom of the drive as indicated on the drawings.

Terminal blocks shall be nonbrittle, interlocking, track-mounted type, complete with a marking strip, covers, and pressure connectors. Screw terminals will not be acceptable. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. In freestanding panels, 8 inches (200 mm) of clearance shall be provided between terminals and the panel base for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Terminals shall be labeled to agree with the identification on the submittal drawings. Each control loop or system shall be individually fused, clearly labeled, and located for ease of maintenance.

All grounding wires shall be attached to the sheet metal enclosure with a ring tongue terminal. The surface of the sheet metal shall be prepared to ensure good conductivity and corrosion protection.

Wires shall not be kinked or spliced and shall be color coded or marked on both ends. The markings or color coding shall agree with the submittal drawings.

With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for at least 600 volts, with a moisture-resistant and flame-retardant covering rated for at least 90°C.

2.3.03 Enclosures. The drive shall consist of factory mounted and wired components within a dead front, grounded, NEMA Type 1 enclosure, or other type when indicated on the drawings. The complete drive package, including accessories, shall fit into the space indicated on the drawings.

Freestanding panels shall be suitable for mounting on a concrete pad and shall include provisions for anchoring to the supporting structure. Suitable lifting facilities shall be provided for handling and shipment.

Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match the identification on the manufacturer's wiring diagrams.

2.3.04 Printed Circuit Boards. All printed circuit boards shall be sprayed on both sides with a conformal coating. The conformal coating shall be a part of the VFD manufacturing process and shall be selectively applied to the circuit board connections only. Heat sinks and resistors on the circuit board shall not be coated. Conformal coating shall be Konform "C416" or HumiSeal.

All plug-in type boards shall be mechanically held at the circuit board connector. Compression fit only at the connector will not be acceptable.

2.3.05 Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop cleaned in accordance with the coating manufacturer's recommendations, and finished with the drive manufacturer's standard coating. Finish color shall be medium gray or the manufacturer's standard color. Dry film thickness of the finish coat shall be at least 4 mils (100 μm). Field painting, other than touch up, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings. When required, a corrosion resistant coating or a special color shall be furnished.

When the drive will be exposed to hydrogen sulfide, all intermediate and finish coating materials shall be guaranteed by the manufacturer to be fume proof and suitable for wastewater plant atmosphere that contains hydrogen sulfide. Coatings that cannot be so guaranteed shall not be used. Lead-free and mercury-free coatings shall be used.

2.4 OPTIONAL EQUIPMENT.

2.4.01 Bypass Switch. When indicated on the drawings, a contactor type bypass switch shall be provided for operation of the ac motor on either the VFD or the ac line. The bypass shall consist of two mechanically and electrically interlocked, NEMA rated magnetic contactors with a common ambient compensated, bi-metallic motor overload relay for motor protection of both circuits. The contactors shall be rated for at least the horsepower (kilowatt) rating of the motor. The bypass contactors shall be part of the packaged unit and shall be mounted within the enclosure of the variable frequency drive.

Door-mounted devices for the bypass shall include an "VFD-Line" switch and a push-pull "Stop/Reset" push button. The controls for the VFD, as indicated on the drawings, shall start and stop the motor, regardless of whether it is connected to the VFD or to the ac line. The "Stop/Reset" push button shall prevent motor operation when it is pulled out. Once the automatic bypass has been activated, no action of the "VFD-Line" switch can change the state of operation. The "Stop/Reset" push button must be depressed before the automatic mode can be restored.

The bypass shall include a door-interlocked circuit breaker so that when the circuit breaker is opened, the output lines are disconnected from the motor. The contactor for the VFD shall serve as an output contactor and shall be electrically interlocked with the input circuit breaker of the VFD so that when the circuit breaker is opened, the drive is disconnected from the motor.

2.4.02 AC Line Reactors. Each six-pulse drive shall be supplied with an input ac line reactor. AC line reactors shall be designed to address performance issues of NEMA MG1-20.55 and to provide proper transient protection of the VFD input power devices. AC Line reactors shall be factory mounted and wired within the VFD enclosure. AC line reactors shall be K-rated per IEEE C57-110 and shall be TCI Model KLR, or approved equal.

2.4.03 Harmonic Filters. When harmonic filters are required to comply with the total harmonic distortion limits specified herein, the VFD manufacturer shall design and provide the required filters. The harmonic filters shall utilize an interlocking contactor that shall be automatically operated by the VFD run circuit. The VFD manufacturer shall be responsible for the complete filter unit, including the filter contactor. Harmonic filters shall be TCI Harmonic Guard Series, or approved equal.

2.4.04 Isolation/Voltage Matching Transformers. Transformers furnished with VFD’s to provide the required operating voltage shall be constructed in accordance with applicable NEMA and ANSI standards. Transformer voltages shall be as indicated on the drawings unless otherwise required by the variable frequency drive. Transformers shall have Class B, F, or H insulation systems. Terminal compartments shall be front-accessible and shall have adequate space for minimum bending radii of the cables to be terminated. The transformers shall be UL listed and shall be provided with a K rating of 15 in accordance with IEEE C57.110.

Transformers rated 15 kVA and lower shall be indoor/outdoor, totally enclosed type, with sound levels generated by each transformer not to exceed 45 dB.

Transformers rated higher than 15 kVA shall be indoor/outdoor, self-air-cooled type with dripproof enclosures and ventilating openings, in accordance with NEMA and NEC requirements. The ventilating openings shall be located to provide adequate cooling even with other equipment located on both sides. Sound levels generated by each transformer shall not exceed 60 dB.

2.4.05 Output dV/dt Filters. When motor feeder lengths are greater than 150 feet, output filters shall be installed inside the drive enclosure on the inverter output. Output filters shall consist of a minimum 1.5 percent impedance reactor, in conjunction with a resistor and capacitor network, to form a damped low-pass filter. Use of output reactors alone is not acceptable. Output filters shall be TCI Model KLC, or approved equal.

2.5 CONTROLS.

2.5.01 Features. Each drive shall include the following features in addition to those indicated on the drawings:

A door mounted membrane keypad with integral 2-line, 24 character minimum LCD display that is capable of controlling the VFD and setting drive parameters. The keypad module shall be programmed with factory set drive parameters in nonvolatile EEPROM or FLASH memory and shall be resettable in the field through the keypad. The keypad module shall contain a self-test software program that can be activated to verify proper keypad operations.

Microprocessor-based regulator. Nonvolatile memory modules shall have a useful life of at least 20 years without requiring battery or module replacement.

Input thermal-magnetic molded-case circuit breaker disconnect with interrupting capacity rated in RMS symmetrical amperes of 14,000, 22,000, or 42,000, and labeled in accordance with UL standard 489. The disconnect shall be mounted inside the controller enclosure and shall have door interlocks and a handle with provisions for padlocking in the "Off" position.

Input line high-speed, current limiting fuses rated 200,000 amperes interrupting and specifically designed for solid-state applications.

Manual speed adjustment.

Indications of power "On", drive "Run", and drive "Fault". Indication of these parameters shall be provided by high intensity push to test pilot lights that utilize 6 volt LED lamps with built-in transformers. Lamps shall be easily replaceable from the front of the indicating light.

Elapsed time meter.

Speed indication - calibrated in percent rpm.

Control circuits of not more than 115 volts supplied by internal control power transformers. Control power transformers shall have additional capacity as required by external devices indicated on the drawings. Control power transformers shall be equipped with two primary leads fused, one secondary lead fused, and one secondary lead grounded.

Automatic controller shutdown on overcurrent, overvoltage, undervoltage, motor overtemperature and other drive fault conditions. Controller shutdown shall be manually reset type. Terminals shall be provided for control wiring from motor temperature switches, or a motor protection relay located in the drive enclosure.

Diagnostic indicators that pinpoint failure and fault conditions. Indicators shall be manually reset to restore operation after abnormal shutdown.

Accept a remote 4-20 mA speed control signal.

Process control output for remote 4-20 mA speed indication, rated 0 to 100 percent speed.

Spare interlock contacts rated 5 amperes at 120 volts ac, wired separately to the unit terminal board. One NO and one NC isolated spare interlock shall be furnished with each drive. Additional interlock contacts shall be provided as indicated on the drawings.

Drive fault and run status contacts for remote indication, rated 5 amperes at 120 volts ac.

Speed droop feature which reduces the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.

Heavy duty, oil-tight pilot devices of the 30.5 mm type.

Individual variable speed profile settings for start, stop, entry, slope, and minimum and maximum speed points.

Coast, controlled ramp, or dc injection selectable modes of stopping.

PID setpoint control selection.

Variable PWM carrier frequency. The inverter output section shall be provided with variable PWM carrier frequency from 500 Hz to at least 10 kHz.

Noise level of installed equipment shall not exceed 85 dB as measured by an appropriate calibrated instrument. This sound level limit shall be met at a minimum of four locations, each not more than 3 feet (0.9 m) above the floor and not more than 10 feet (3 m) from the equipment. This requirement shall apply to all drives, motors, filters, reactors, and transformers supplied with the drive.

2.5.02 Diagnostics. Diagnostic indicators on the face of the drive shall display the type of fault responsible for drive shutdown, warning, or failure. If two or more faults occur simultaneously, the diagnostic segment shall record or indicate each condition. The drive shall be capable of storing 10 events with a time and date stamp for each event.

2.5.03 Motor Protection Relay. When indicated on the drawings, a three phase modular electronic relay to protect motors against overloads (51/49), acceleration time, RTD over temperature (49), negative sequence current (46), variable current unbalance (46), phase loss (46), multiple starts (48), short circuit (50), ground fault (50G/51G), hot motor compensation, undercurrent minimum load (37), phase reversal (46), variable lockout on thermal trip, and mechanical jam shall be incorporated into a single field motor overload, stator RTD alarm, ground fault alarm, undercurrent alarm, unbalance alarm, thrust and guide bearing RTD alarm, broken RTD alarm, and self-test alarm shall be provided. Other features shall include alphanumeric display, actual motor values display, status indication, analog output load amperes, analog output motor thermal capacity, and analog output stator temperature. The relay shall be Multilin "369 Motor Management Relay."

2.6 ACCESSORIES.

2.6.01 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.7 TESTING. All power switching components shall be prerun under anticipated operating temperature and load conditions.

2.7.01 Factory Testing. After the drive system has been assembled at the manufacturer's facility, it shall be tested for at least 24 hours before it is shipped. The complete drive system, including all peripherals, shall be factory tested under simulated operating conditions, including normal operating sequences and fault conditions. Contact closure inputs and simulated driven-outputs shall be connected to the system input/output modules.

A test report summary indicating satisfactory final test results shall be submitted to Engineer before shipment of the equipment.

2.7.02 Secondary Factory Testing. Unless otherwise indicated, the drive units shall be assembled with the driven equipment for shop testing . The drive manufacturer shall provide the services of a qualified representative to work with the equipment manufacturer at the equipment manufacturer's facility. The representative shall advise and assist in assembling and testing the equipment and drive unit packages.

Personnel conducting the tests shall be competent, authorized representatives of the equipment and drive manufacturers who are familiar with operation of the equipment furnished and who have satisfactory experience in conducting similar tests. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results. Five copies of the report shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The information collected shall be used as a basis for determining acceptability of the manufacturer's test results. In case of conflict, interpretations and calculations made by Engineer will govern.

Testing shall be conducted in a manner acceptable to Engineer. At least 2 weeks before the proposed testing date, Contractor shall notify Engineer of the testing date and shall submit a report from the equipment manufacturer detailing the proposed performance testing.

PART 3 - EXECUTION

3.1 PREPARATION FOR SHIPMENT. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked. Complete packing lists and bills of material shall be included with each shipment.

3.2 INSTALLATION CHECK. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.3 FIELD TESTING.

3.3.01 Field Acceptance Testing. After installation of the system at the site of the work and checkout by the drive manufacturer, a field acceptance test shall be conducted jointly by the drive manufacturer and the manufacturer of the driven equipment.

The field acceptance test shall consist of repeating the factory acceptance testing procedure and an additional 5 days of similar testing, during which the system shall run continuously without loss of basic functions. Functional tests shall demonstrate satisfactory operation of all interlocks, alarms, and normal operating sequences. The drive manufacturer shall use suitable test equipment to identify and correct malfunctions. Failure of redundant equipment will not be considered as downtime, provided that automatic failover occurs as specified herein and, that in the opinion of Engineer, the failure was not caused by deficiency in design or installation. Repeated failure of any component shall be cause for the acceptance test to be terminated and restarted.

3.3.02 Harmonic Distortion Test. Contractor shall provide temporary four-channel power line monitoring equipment at the site to graph and record the harmonic line distortion for ac voltage and current, and to compute individual harmonic values up to the 50th harmonic as well as total harmonic distortion (THD) and total demand distortion (TDD). Distortion testing shall include all drives furnished under this section and all existing drives as specified in paragraph 2.2.04 and as indicated in the Contract Documents.

The monitoring equipment shall include a four-channel power line monitor, temperature and humidity compensation probes, a recorder, and any additional instruments required to compute harmonic values, THD, and TDD. The equipment shall be Basic Measuring Instruments "Model 3030A Power Profiler" or Dranetz "Model 8000".

Measurements shall include phase-to-phase, phase-to-neutral, and neutral-to-ground. The harmonic distortion shall be monitored at the primary and secondary points of common coupling. The test shall be run for the full range of drive operation to the extent practicable.

Graphs of harmonic spectra and of current waveforms shall be submitted for the following running conditions of the equipment:

All drives at 100 percent speed.

Half, two-thirds, or three-fifths of each type of drive at 60 percent speed and the others at 100 percent speed.

All drives at 60 percent speed.

All drives off.

The test shall be conducted by qualified personnel acceptable to Engineer.

3.4 TRAINING OF OWNER'S PERSONNEL. Employees of Owner shall be trained in the proper operation, troubleshooting, and maintenance of the equipment. Training shall be conducted by a qualified representative of the drive manufacturer and shall consist of at least 16 hours of combined classroom and hands-on instruction. Training shall be conducted at a place and time mutually agreeable to Owner and the drive manufacturer.

End of Section

SECTION 16220

GENERAL PURPOSE INDUCTION MOTORS

PART 1 – GENERAL

1.1 SCOPE. This section covers single and three-phase, small (fractional) and medium (integral) horsepower, alternating current motors rated 500 horsepower and less (NEMA MG1-1998), as specified herein and as indicated on the drawings.

Motors shall be designated and shall be located as indicated on the drawings.

1.2 GENERAL. Motors furnished under this section shall be fabricated, and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.03 Workmanship and Materials. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thickness so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Lubrication. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

Lubricants shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment. Unless otherwise specified or permitted the use of synthetic lubricants will not be acceptable.

Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.2.05 Abbreviations. Reference to standards and organizations shall be indicated by the following abbreviated letter designations:

AFBMA	Anti Friction Bearing Manufacturers Association
ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories
USN	United States Navy

1.2.06 Governing Standards. Motors furnished under this section shall be designed, constructed, and tested in accordance with NEMA MG1-1998 and IEEE 112, Test Method B.

Motors shall be designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

Motors covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event, no third-party testing laboratory provides the required listing; an independent test shall be performed at Contractor's expense. Before testing, Contractor shall submit a copy of the testing procedure that will be used in evaluating the equipment.

Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.2.07 Nameplates. The motor nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MGI-10.38 or MGI-20.60, as applicable.

1.3 SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data shall include, but shall not be limited to, the following:

Motors

Name of manufacturer.

Type and model.

Type of bearing and method of lubrication.

Rated size of motor, hp (kW), and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Net weight.

Efficiency at full, 3/4, and 1/2 load.

Full load current.

Locked rotor current.

Space heater wattage, where applicable.

Motor temperatureswitch data, where applicable.

RTD data, where applicable.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Six (6) operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Assembly, installation, alignment, adjustment, and checking instructions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

The CONTRACTOR shall furnish the ENGINEER with six (6) certified copies of characteristic curves for each motor furnished (except 115 volt motors) and all other data required for designing the control equipment.

1.5 DESCRIPTION 1.5.01 The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install Electric Motors.

1.6 RELATED DOCUMENTS

1.6.01 Section 16120, Wires and Cables 600 Volt and Less
1.6.03 Section 16150 Low Voltage Variable Frequency Drives

1.7 DESCRIPTION OF SYSTEMS

1.7.01 Electric motors are for the operation of equipment furnished and installed by other trades.

1.7.02 The types of motors shall be selected to be suitable for the ambient conditions in which they are to operate, including moisture, dust, temperature, etc.

1.8 WORK SPECIFIED

1.8.01 Furnish all labor, materials, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical motors as specified in all Sections of these specifications or as indicated.

1.8.02 Place motor operated equipment and accessories into proper adjustment and operating condition so that the component parts function together as a workable unit.

1.8.03 Provide all labor, material, and equipment required to install, wire, connect, set, and place in operation all motors as part of equipment furnished by other trades as specified and as shown on the plans of these contract documents. The work shall include all conduits, fittings, wires, mounting systems, etc., as shown in the specifications and as instructed by the equipment manufacturers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. The motors shall be manufactured by General Electric, Ideal, Reliance Electric Co., Siemens Energy & Automation, Inc., U. S. Motors, or approved equal.

2.2 SERVICE CONDITIONS. Service conditions for motors shall be as required for driven equipment. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or environment as required.

Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40°C ambient, altitude exceeding 3,300 feet (1005 m), explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, or frequent starting, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits.

Manufacturer's standard motor may be supplied on appliances, tools, and unit heaters. If the manufacturer’s standard motor is not supplied, a redesign of the general purpose induction motor may be necessary. In all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

Unless specified otherwise, all motors shall be designed for full voltage starting and to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

Motors utilizing a reduced-voltage, auto-transformer starter shall be capable of reduced-voltage starting at a 65 percent tap setting.

When powered from a variable frequency drive (VFD), motors shall be specifically selected for service with a variable frequency type speed drive and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the variable frequency drive. All motors driven by VFD’s shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

Requirements for motor arrangement, speed type, torque type, and special enclosures shall be as required for the driven equipment and as indicated in that section.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS. Design and construction of each general-purpose motor shall be as specified herein and as indicated.
2.3.01 Voltage. Motor voltage shall be as indicated in the driven equipment section and shall be designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

2.3.02 Nameplate Horsepower. Motor nameplate horsepower (kW) shall be equal to or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp (kW)	Other than Open	1.15
Integral hp (KW)	Open	1.15
	Other than Open	1.15

2.3.03 Insulation. Motor insulation and temperature rise above 40°C design ambient (measured by resistance method) may be Class F with 90°C rise at 1.15 SF.

2.3.04 Enclosures. All motors shall be self-ventilated. All self-ventilated open type motors, including those with drip-proof, splash-proof, and weather protected enclosures, and the fan covers of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.

Vertical motors of the open drip-proof type shall be provided with drip hood of acceptable shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing.

Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.

All fractional horsepower motors shall be totally enclosed.

2.3.05 Totally Enclosed Motors. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan cooled motors shall be cast iron. External cooling fans for fan cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron, or plastic.

2.3.06 Outdoor Motors. Outdoor motors shall have NEMA weather protected enclosures. All exposed metal surfaces shall be protected, where practical, with a corrosion resistant polyester coating. Exposed uncoated surfaces shall be of a corrosion resistant metal. Enclosure exterior and interior surfaces, air gap surfaces, and windings shall be protected with a corrosion resistant alkyd enamel, polyester, or epoxy coating.

2.3.07 Motors for Hazardous Locations. Motors for hazardous locations shall be in accordance with the NEC and of the correct type enclosures for the particular service as specified in NEMA MG 1. Motors shall meet the requirements of UL 674. Motors shall be suitable for a Class I, Group C and D, Division 1 area; or for a Class I, Group C and D, Division 2 area as indicated on the drawings.

2.3.08 Encapsulated Windings. When indicated, motors shall be provided with a totally enclosed, fan-cooled enclosure with special corrosion-resistant finish and encapsulated windings meeting the requirements of NEMA MG 1-1.27.2.

2.3.09 Severe Duty Motors. When indicated, motors shall be provided with a totally enclosed, fan-cooled enclosure with special corrosion-resistant finish and encapsulated windings meeting the requirements of NEMA MG1-1.27.2 and IEEE 841.

2.3.10 Conduit Boxes. Externally mounted conduit boxes shall be in accordance with NEMA MG 1. The conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90 degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line drawings.

The main conduit box shall be sized for all indicated accessory leads. All medium voltage motors shall have conduit boxes sized for stress cones on the cable leads.

Motors shall have terminal boxes for auxiliary equipment with terminal leads grouped in boxes for all external connections. Terminal boxes shall be oversized and shall have terminals and conduit hubs sized for the cables and conduit indicated on the drawings.

Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

Motor conduit boxes shall be oversized at least one size larger than NEMA standard. Size shall be increased as required for stress cone terminations and current transformers.

Totally enclosed and explosion-proof motors shall have cast iron terminal boxes.

2.3.11 Leads. Motor power leads shall be wired into the motor terminal housing. Unless otherwise specified, space heater leads shall be wired into a separate motor space heater terminal box. All motor leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.

All motors rated 100 horsepower (74 kW) and larger, all motors furnished with unidirectional blowers, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

Leads for dual-voltage rated or for multi-speed motors shall be easily connected or reconnected in the terminal housing for the operating voltage or for the specified speeds. Permanent instructions for making these connections shall be furnished inside the terminal housing or on the motor frame or nameplate.

Motors shall also have flexible leads of sufficient length to extend beyond the face of the box for a distance of not less than 4 inches (10.16 cm).

2.3.12 Terminals. Cable type leads shall be provided with Burndy Type YA or acceptable equal compression type connectors.

2.3.13 Grounding Connections. All motors, including those with resilient mountings, shall be furnished with a ground connection.

2.3.14 Bearings. All bearings shall be self-lubricating, shall have provisions for re-lubrication, and shall be designed to operate in any position or at any angle.

Motor bearings shall be anti-friction type with L_{10} life rating of 40,000 hours in accordance with AFBMA Standards.

All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy re-lubrication from the outside of the motor while the motor is in service.

Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.

2.3.15 Rotors. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec (2.03 mm/s) or less.
2.3.16 Shafts. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.

2.3.17 Torque Characteristics. Motors rated 200 horsepower (149 kW) and less shall have torques and locked-rotor current in accordance with NEMA MG 1, Part 12.

2.3.18 Motor Space Heaters. When indicated, motors shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.

2.3.19 Temperature Sensing Devices. When indicated, each motor shall be furnished with resistive temperature devices (RTD) placed to sense temperature in the motor windings and bearings. All RTD's shall be 100 ohm, platinum type. Each motor shall be equipped with a pair of RTD's in each phase winding and a pair in the thrust and guide bearings. All RTD's shall be connected with a twisted shielded triad to the motor protection relay and shall be connected as indicated on the electrical schematics and one-line diagrams.

When indicated, each motor shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amperes at 120 volts ac. The contacts shall be wired in series with the end leads brought out to a separate motor terminal box. Switches shall be as recommended by the motor manufacturer.

When indicated, temperature detectors for sleeve or anti-friction bearings, complete with detector head and holder assemblies, shall be furnished in accordance with the applicable requirements of ANSI MC96.1 and IEEE 119.

2.3.20 Assembly. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

2.3.21 Efficiency. Minimum motor efficiencies shall conform to the requirements of Energy Policy Act of 1992 (EPACT) and when indicated, shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or greater than values indicated in the following table. Efficiency shall be determined in accordance with IEEE 112, Test Method B.

Vertical motors shall be premium efficiency type and shall have efficiency values equal to or greater than those indicated in the following table minus 0.50.

		Nominal Efficiency Values Open Drip Enclosure				Nominal Efficiency Values TEFC Enclosure			
Motor		3600	1800	1200	900	3600	1800	1200	900
kW	hp	rpm	rpm	rpm	rpm	rpm	rpm	rpm	rpm
0.7	1	84.0	83.0	80.5	75.0	75.5	81.5	81.5	75.5
1.1	1.5	82.5	84.0	84.5	78.0	82.5	84.0	86.5	80.0
1.5	2	84.0	84.0	86.5	86.5	84.0	84.0	87.5	85.5
2.2	3	85.0	87.5	88.0	89.5	87.0	88.0	89.0	86.5
3.7	5	87.5	88.5	89.0	89.5	88.0	88.0	89.5	85.0
5.6	7.5	88.5	89.5	90.0	88.5	90.0	90.0	90.0	86.5
7.5	10	89.0	90.0	91.0	91.0	91.0	90.0	91.0	91.0
11.2	15	90.2	91.7	91.0	91.0	91.0	92.0	92.0	91.0
14.9	20	91.7	92.4	91.7	92.0	92.0	93.0	92.0	91.0
18.7	25	92.4	93.0	92.4	92.0	92.0	93.0	93.0	91.0
22.4	30	93.0	93.0	93.0	93.0	93.0	93.0	93.0	93.0
29.8	40	93.0	94.0	93.5	93.0	93.0	94.0	94.0	93.0
37.3	50	93.0	94.1	93.5	93.0	92.4	94.0	94.0	93.0
44.8	60	93.0	95.0	94.5	94.0	93.5	95.0	95.0	93.0
56	75	94.0	95.0	95.0	94.0	93.6	95.0	95.0	94.0
74.6	100	94.5	95.0	95.0	95.0	95.0	95.0	95.0	94.0
93.2	125	95.0	95.0	95.0	95.0	95.0	95.0	95.0	94.0
112	150	95.0	95.0	95.0	95.0	95.0	95.0	95.0	94.0
149	200	95.0	95.0	95.0	95.0	95.0	95.0	95.0	94.1
186	250	95.0	95.4	95.4	95.0	95.4	95.0	95.0	94.5
224	300	95.0	95.4	95.5		95.4	95.4	95.0	
261	350	95.0	95.4	95.4		95.4	95.4	95.0	
298	400	95.4	95.4			95.4	95.4		
336	450	95.8	95.8			95.4	95.4		
373	500	95.8	95.8			95.4	95.8		

2.4 ACCESSORIES.

2.4.01 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs, and appropriate fittings for adding bearing lubricant when required. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2.5 ANCHORS. Contractor shall furnish suitable anchors for each item of equipment as required for driven equipment.

2.6 SHOP PAINTING. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for coating. Electric motors shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

2.7 BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits of USN MIL-STD-167. Residual imbalance shall not exceed:

4W/N (oz*in).

Where:
W = Weight of rotor in pounds
N = RPM for N greater than 1,000

2.8 TESTS. For induction motors larger than 100 hp., complete tests of each motor furnished shall be made and certified test data sheets shall be submitted, witness shop tests are required by the detail specifications pertaining to the equipment. Each motor shall be tested for efficiency and power factor at 50, 75, and 100 percent of its rated horsepower for temperature rise, torque, starting current, and dielectric strength, and for compliance with all specified performance requirements.

For induction motors 5 hp. up to, and including, 100 hp., six (6) copies of routine test reports of electrically duplicated motors shall be furnished.

For motors 3 hp or less, no test data need be furnished.

Additional tests on individual motors shall be as specified in the Master Specification section for the equipment driven by the motor.

2.9 ADDITIONAL REQUIREMENTS. Unless otherwise specified or permitted, all electric motors furnished and installed by the Contractor shall conform to the requirements hereinafter set forth.

2.9.01 Ratings of Motors

2.9.01.01 Every motor shall be of sufficient horsepower and speed to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or specified temperature limits.

2.9.01.02 Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Electrical Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.

2.10 TYPE OF MOTORS

2.10.01 All motors shall be of a type having starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.

2.11 GENERAL DESIGN OF MOTORS

2.11.01 Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture and slightly acid or alkaline conditions.

2.11.02 Bearings shall be of the self-lubrication type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant. The motors shall be lifetime lubricated with silicone grease. Antifriction bearings shall be designed to be re-greasable and initially shall be filled with grease suitable for ambient temperature of 40° C. Bearings shall be AFBMA Types BC or RN, heavy duty, or shall otherwise be shown to be suitable for the intended application in terms of B-10 life rating, Class M3 or better. All grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type by the Alemite Division of the Stewart-Warner Corporation or approved equal.

2.11.03 Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.

2.11.04 Locked rotor current shall not be greater than specified in NEMA Standard MGI-12.32, Design "N".

2.11.05 Motor shall be totally enclosed in conformance with NEMA Standard MGI-10.35. Small fan motor may be open type if suitably protected from moisture, dripping water and lint accumulation.

2.11.06 When indicated, each motor shall be provided with x-y, velocity type vibration sensors with transmitters at each end of the motor. The sensors & transmitters shall be as per 17550, 3.2.17. All wiring shall be brought out to a separate terminal box for external connections.

2.12 SINGLE PHASE MOTORS AUXILIARY DEVICES

2.12.01 Single phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housing or housed in suitable

enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.
2.13 SPECIAL MOTORS

2.13.01 Hoists and other devices complying with special safety codes shall be furnished complete with their control equipment and with all accessories and safety devices for code-approved, safe and efficient operation.

PART 3 - EXECUTION

3.1 INSTALLATION. Each motor will be installed in accordance with the requirements of the Master Specification section for the equipment being driven.

End of Section

SECTION 16310

SECONDARY INTEGRAL UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 SCOPE. This section covers secondary integral unit substation equipment that shall be furnished, installed, and tested as specified herein and as indicated on the drawings. Equipment shall meet the following requirements, and the design conditions and features as indicated.

Each secondary unit substation shall consist of one or more enclosed high voltage incoming line sections, close-coupled three phase power transformer(s), and an enclosed secondary low voltage section(s) all as defined in NEMA Publication 210 - 1970. Low voltage section shall be a terminal chamber, circuit breaker, panelboard, low voltage switchboard or switchgear, or motor control center as required.

Secondary integral unit substation equipment shall meet the design conditions and features indicated.

Secondary integral unit substation equipment shall be designated and shall be located as indicated.

1.2 GENERAL. Equipment furnished under this section shall be fabricated, assembled, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer. Working space in front of the unit substations shall meet the minimum requirements of the latest NFPA 70: National Electrical Code.

1.2.03 Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thickness so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

ANSI	American National Standards Institute
AWG	American Wire Gage
FS	Federal Specifications
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.2.05 Governing Standards. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

IEEE C37.20.3, IEEE C37.20.4 and NEMA SG-2 (high-voltage switches)

ANSI C26.1 and NEMA LA1 (lightning arresters)

NEMA SG-5, and UL 1558 (low-voltage switchgear)

NEMA PB 2 (switchboards)

ANSI C57.12.00 & C57.90 (liquid immersed transformer)

ANSI C57.12.00, C57.90 & C57.94 (dry type transformer)

NEMA AB1 (molded case circuit breakers)

NEMA PB 210 (unit substation)

NEMA ICS 6 (enclosures)

The equipment shall also conform to all the applicable standards of ANSI, NEMA, UL, and NEC 230-95, 240, 380, 384, 430, 450, and 710.

Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure that will be used.

1.2.06 Nameplates. When indicated, nameplates with unit description and designation of each control or indicating device shall be mounted on all hinged doors and rear cover plates. Nameplates shall have black baked enamel 3/4 inch (19 mm) high letters for section identity and 1/8 inch (3 mm) letters for other information on anodized aluminum plate.
Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

1.2.07 System Characteristics. The secondary unit substation will be connected to an electric system with characteristics as indicated on the drawings.

1.3 SUBMITTALS. Complete assembly, foundation requirements, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the substation, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data shall include, but shall not be limited to, the following:

Incoming Line Section

Elevation, plans, and weight.

Fuse time-current characteristic curves.

Rating and specifications for switches.

Surge arrester ratings and characteristics.

Transformer

Elevation, plan, weight, and nameplate.

Shop tests.

Outgoing Line Section

Elevation, plan, weight, and bill of material.

Single-line, control schematic, wiring connection, and wiring interconnection diagrams.

Circuit breaker time-current characteristic curves.

1.3.01 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Assembly, installation, alignment, adjustment, and checking instructions.

Frame sizes and trip settings of all breakers

Short circuit and Coordination analysis including curves of all breakers, new transformer damage curve, curves for all fuses and other protective devices

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 SHIPPING, STORAGE, AND HANDLING. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked as required. Complete packing lists and bills of material shall be included with each shipment.

1.5 SPARE PARTS. Spare parts shall be provided as indicated on the Contract Documents.

Spare parts shall be suitably packaged with labels indicating the contents of each package and shall meet all the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.. Spare parts shall be delivered to Owner as directed.

1.6 COORDINATION STUDY. When a coordination study of the power distribution system will be conducted as specified in the electrical section Master Specification Section 16052, Coordination Study and Arc Flash Analysis. The equipment manufacturer shall provide the following information to Engineer with the initial equipment shop drawings:

Curves for each current-limiting fuse.

Coordination curves for each circuit breaker.

Damage curves and protection evaluated in accordance with ANSI/IEEE C57.109 for each transformer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. The equipment shall be as manufactured by Square D/ Schneider Electric, Eaton Cutler-Hammer, General Electric, Siemens Energy & Automation, or ABB,or .

2.2 DESIGN AND CONSTRUCTION. Each substation shall consist of a primary incoming line section, a transformer section, and a secondary outgoing line section. Each substation shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the drawings or specified herein.

2.2.01 Sills and Anchors. Contractor shall furnish steel channels, floor sills, and anchor bolts as required for proper installation.

2.3 PRIMARY INCOMING LINE SECTION. The primary incoming line section for each substation shall consist of line terminals or switches and fuses as indicated on the drawings.

2.3.01 Primary Selective Radial Switch. Each primary selective radial switch shall consist of two parallel two-position (Open/Closed), three-pole, load break type, air-or vacuum-interrupter switches, with stored energy mechanism. The switches shall be key interlocked so that both incoming line switches cannot be closed at the same time. Each switch shall be rated 5, 15, 25, or 34.5 kV; 60, 95, or 150kV BIL; 600 or 1200 amperes continuous; with a momentary asymmetrical rating of 40,000, 60,000, or 80,000 amperes as indicated. All three poles of each switch shall open simultaneously by a handle on the front of the primary incoming line section compartment. Each switch shall have a mechanical position indicator. Each switch shall be enclosed in a separate compartment to permit maintenance on one switch while the other one is energized. A shatterproof window shall be provided to permit visual inspection of each interrupter switch.

2.3.02 Two-Position Air-Interrupter Switch. Each two-position (Open/Closed) air-interrupter switch shall be of the three-pole, load break type, with stored energy operating mechanism. Each switch shall be rated 5, 15, 25, or 34.5 kV; 60, 95, or 150kV BIL; 600 or 1200 amperes continuous; with a momentary asymmetrical rating of 40,000, 60,000, or 80,000 amperes as required. All three poles of each switch shall open simultaneously by a handle on the front of the primary incoming line section compartment. Each switch shall have a mechanical position indicator.

2.3.03 Incoming Line Terminals. Incoming line terminals shall be crimp or compression type and shall be suitable for terminating shielded cables of at least the size indicated on the drawings with Class 1 type stress cones. The incoming lines will enter from the top or bottom of the enclosure as required. Adequate space shall be provided for stress cones on the incoming lines. Bus connections shall be provided between the connecting terminals and the disconnecting switches or the transformer.

2.3.04 Current-Limiting Fuses. Current-limiting fuses or electronic power fuses as indicated, shall be included in each switch compartment to protect the transformer. The fuses and fuse holders shall be rated approximately 200 to 250 percent of transformer full load amperes continuous. Access to the fuse compartment shall be by a hinged door interlocked with the switch so that the door cannot be opened unless the switch is opened. The door shall be on the front of the enclosure.

Fuses shall be disconnect style and shall have provisions for grounding on the load side of each fuse and on the enclosure ground bus. Each fuse shall be equipped with a blown fuse indicator that provides visible evidence of fuse operation while installed in the fuse mounting. Fusible elements shall be nonaging and nondamageable, so it is unnecessary to replace unblown companion fuses following a fuse operation. Fusible elements shall be protected against damage caused by current surges.

Any arcing accompanying power fuse operation shall be contained within the fuse and any arc products and gases produced shall be vented through exhaust control devices.

One hundred percent spare fuses shall be provided for each switch. Spare fuses shall be placed in a spare fuse compartment on each door.

2.3.05 Buses. All phase bus conductors shall be tin-plated copper and shall be mounted on NEMA class insulators. A 600 ampere copper ground bus with a connector for incoming ground cable shall be provided.

2.3.06 Space Heaters. Space heaters for 120 volt ac service shall be provided in each high-voltage switch compartment to prevent condensation in the switch enclosure. The space heaters shall be controlled by a thermostat factory-set to maintain the enclosure above the dew point for anticipated environmental conditions. Space heaters shall be connected to a circuit breaker disconnect in the transformer secondary terminal compartment. The space heater power supply shall be from an external source or shall be from an integral power supply provided in the secondary compartment as indicated.

2.3.07 Lightning Arresters. Intermediate class metal oxide lightning arresters shall be provided, connected at the incoming terminations, and securely grounded to the metal structure. Arrester kV ratings shall be 3, 4.5, 36, or 39 kV, as indicated.

2.4 LIQUID-INSULATED TRANSFORMER SECTION. Each transformer shall be 3 phase less-flammable liquid-insulated or oil-insulated unit substation type, as indicated, with kVA and voltage ratings as indicated on the drawings and as specified herein. Less-flammable liquid shall be fire resistant hydrocarbon type. Transformers filled with silicone fluid will not be acceptable. Each transformer shall match and line up with the primary switch or switches. Bus connections shall be provided between the transformer high-voltage bushings and the interrupter switch or switches. Each transformer shall conform to NEMA standards for liquid-insulated transformers. Transformers shall be K-rated.

2.4.01 Rating. Each transformer shall be rated as indicated on the drawings, and the primary winding shall have four 2-1/2 percent fully rated taps, two above and two below rated voltage.

An OA rating shall indicate that the transformer will carry its continuous rating with average winding temperature (by resistance) that shall not exceed 150°F (65°C) rise, based on an average ambient of 85°F (30°C) over 24 hours with a maximum of 105°F (40°C).

An OA/OA rating shall indicate that the transformer will carry its continuous rating with average winding temperature (by resistance) that shall not exceed 130°F (55°C) rise, based on an average ambient of 85°F (30°C) over 24 hours with a maximum of 105° F (40°C). The insulation system shall allow an additional 12 percent continuous output at 150°F (65°C) rise without any decrease in the transformer's normal service life.

An FA rating shall indicate the transformer shall include a temperature monitor, wiring, fans and auxiliary equipment necessary for automatic temperature controlled forced air cooling to obtain 15 percent or 25 percent additional capacity. Control power for fans shall be from a control power transformer in the transformer secondary terminal compartment or from a separate control power source as indicated on the drawings.

An FFA rating shall indicate the transformer shall include the same provisions as for the FA rating except the fans will be provided in the future.

Transformers shall be derated when installed at an altitude exceeding 3,300 feet (1005 m).

2.4.02 BIL. The BIL of the high-voltage windings shall conform to the following:

Nominal System Voltage kV	Basic Impulse Level kV
1.2	45
2.4	60
4.8	75
8.32	95
14.4	110
23.0	150
34.5	200

2.4.03 Impedance. Transformers shall have the following impedance ($\pm$ 7.5 percent) at their lowest self-cooled rating:

Transformer Size kVA	Impedance Percent
225	5.0
300 & 500	5.0
750 & 1000	5.75
1500 & 2000	5.75
2500 & 3000	5.75
4000 & 5000	5.75

2.4.04 Construction. Each transformer tank shall be fabricated of steel plate reinforced by structural steel members and shall have a structural steel base. All structural members, attachments, assemblies, tank seams, and tube connections shall be welded. All bolted, flanged connections shall be provided with suitable gaskets. The tank shall be equipped with lifting lugs suitable for convenient and safe handling of the transformer when fully assembled and filled with liquid. The tank shall be filled and sealed at the factory.

Incoming and outgoing sections of each transformer shall be located on opposite ends of the transformer and shall be equipped with tamper-resistant hardware.

2.4.05 Efficiency. Each transformer shall meet the minimum efficiency standards required by the U.S. Department of Energy (10 CFR Part 431).

2.5 AIR- INSULATED TRANSFORMER SECTION. Each transformer shall be 3 phase, air-insulated dry type, with kVA and voltage ratings as indicated on the drawings and as specified herein. Each transformer shall match and line up with the primary switch or switches. Bus connections shall be provided between the transformer high-voltage bushings and the interrupter switch or switches. Each transformer shall conform to NEMA standards for dry type transformers. Transformers shall be K-rated.

2.5.01 Rating. Each transformer shall be rated as indicated on the drawings, and the primary winding shall have four 2-1/2 percent fully rated taps, two above and two below rated voltage. The electrical insulation shall utilize Class H material in a fully rated 430°F (220°C) system. Design temperature rise shall be based on 85°F (30°C) average ambient over a 24 hour period, with a maximum of 105°F (40°C). The windings shall be impregnated with polyester or silicone resin by a vacuum pressure process.

As indicated on the drawings, the transformer shall be designed for a temperature rise of 300°F (150°C), 240°F (115°C), or 175°F (80°C) and shall be capable of continuously operating at 0, 15, or 35 percent above base nameplate kVA capacity without any decrease in the transformer's normal service life.

An FA rating shall indicate that the transformer shall include the necessary wiring, temperature monitor, relays, and fans required to increase the kVA rating by 33 percent. Control power for fans shall be from a control power transformer in the transformer secondary terminal compartment or from a separate control power source as indicated on the drawings or as required.

An FFA rating shall indicate the transformer shall include the same provisions as for the FA rating except the fans will be provided in the future.

2.5.02 BIL. The BIL of the high-voltage windings shall conform to the following:

Nominal System Voltage kV	Basic Impulse Level kV
1.2	10

2.4	20
4.8	30
8.32	45
14.4	60
34.5	150

2.5.03 Impedance. Transformers shall have the following impedance ($\pm$ 7.5 percent) at their lowest self-cooled rating:

Transformer Size kVA	Impedance percent
112.5	3.5
150	4.5
225	5.75
300	5.75
500 & 750	5.75
1000 & 1500	5.75

2.5.04 Construction. The transformer shall be supplied in a knockdown case design, for ease in fitting through limited openings. The case shall be constructed of USS 13 gage (2.28 mm thick) carbon steel sheet and shall be equipped with removable panels for access to the core and coils. Front and rear panels shall be provided with ventilating grills. The transformer shall have provisions for lifting and jacking.

2.6 SECONDARY OUTGOING LINE SECTION.
The secondary outgoing line section shall be factory installed on, or close-coupled to, the transformer. It shall consist of an air-filled terminal compartment, a secondary switchgear section and all other equipment indicated on the drawings or as required.

2.6.01 Air-Filled Terminal Compartment. The air-filled terminal compartment shall consist of a full-height NEMA rated enclosure with features as required. The compartment shall enclose the transformer low voltage bushings and terminal connectors for secondary cables or bus.

A 480-120 volt control power transformer with primary and secondary breakers, for space heaters or for fan cooling, shall be provided in the compartment.

2.6.02 Secondary Switchgear. The switchgear section shall be a main-tie-main configured low voltage, metal-enclosed switchgear with draw-out type power circuit breakers. The sides and rear of the enclosure shall be covered with removable bolt- on plates. Bus bars shall be tin-plated copper with bolted connections at joints and sized for the ampere ratings indicated on the design drawings. The switchgear assembly including all breakers, buses, terminations and any other power distributing conductors shall be rated to withstand and interrupt an available fault current of 65,000 amps.

2.6.03 <u>Draw-out Circuit Breakers.</u> Low voltage draw-out power circuit breakers shall be provided in the frame ratings, quantities and configurations shown on the design drawings. Electronic trip units shall be provided with each breaker according to the requirements of subsection 2.6.04. Power monitoring devices shall be provided where indicated on the design drawings.

2.6.04 <u>Electronic Trip Units.</u> Each trip unit shall be supplied with a trip plug sized to the trip rating indicated on the design drawings. The trip units shall have adjustable time-overcurrent settings that include: long-time pickup and time delay, short-time pickup and time delay, and an instantaneous pickup capable of being turned off.

Each trip unit shall also be provided with ground fault protection with an adjustable pickup not exceeding 1200 A, and adjustable time delay. A neutral current transformer shall be included where required for proper ground fault protection.

Each breaker trip unit shall be capable of communicating the status of the breaker (Open/Closed/Tripped), trip settings and trip event data through the plant's existing process network using either a direct Ethernet connection or by sending the information through its associated power monitoring device as described in section
2.6.06.

2.6.05 <u>Automatic Transfer System.</u> An automatic transfer system shall be provided to facilitate automatic or manual operation of the main-tie-main configuration of the switchgear. The system shall be controlled through a PLC with a touch-screen interface for manual control of the system. The transfer system shall be capable of monitoring the synchronization of the two main power feeds and performing a closed transition when safe to do so without damaging any equipment. The Owner shall be provided with backup copies and loading procedures for any software programs
used to control or interface with the system.

2.6.06 <u>Power Monitoring</u>. Information from all power monitoring devices located within the substation shall be made available for communication through the plant's existing Ethernet process network utilizing an open data format compatible with the Ovation DCS system.

Each main and feeder breaker shall be provided with power metering devices capable of measuring the voltage, phase currents, frequency, kilowatts, (kilo)watt- hours, power factor, total harmonic distortion, and the first seven harmonics as a minimum.

Trip units with integral power metering that are capable of providing all required functions listed in the paragraph above may be supplied for the feeder breakers. Separate power monitoring units shall be provided for the incoming feeds to the main breakers. If capable, the power metering units may be used to communicate information from their associated breaker's trip unit to the network.

2.7 ACCESSORIES.

2.7.01 Special Tools and Accessories. All special tools and accessories necessary for testing and maintenance of the equipment shall be furnished.

2.7.02 Transformer Accessories. When a liquid-insulated transformer is required, it shall be provided with the following accessories:

Magnetic-type liquid gauge with low level alarm contact and a mark at normal 75°F (25°C) level.

Upper and lower filter press connections.

Liquid sampling valve.

Drain valve.

Liquid temperature dial-type thermometer with a high temperature alarm contact.

Pressure-vacuum gauge of suitable range.

Stainless steel nameplate with information as prescribed in ANSI standards.

Grounding pad with clamp-type terminal for 250 kcmil (120 mm^2) ground cable.

Tank pressure relief device with alarm contact.

Pressure test valve.

Tank lifting lugs.

Gang-operated tap-changer control switch.

Handhole.

2.7.03 Transformer Accessories. When a dry type transformer is required, it shall be provided with the following accessories:

Diagram instruction plate.

Removable panel for access to high voltage strap type connector taps for de-energized tap changing.

Two ground pads with clamp-type terminals for 250 kcmil (120 mm^2) ground cables.

2.8 SHOP PAINTING. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61 for indoor equipment, ANSI 61 or 70 for outdoor equipment, or another color as required. Field painting, other than touch up painting, will not be required. Quantities of coating material and thinner, as required, shall be furnished to permit field touch up painting of damaged coatings.

The underside of equipment installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is considered to be the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting.

2.9 SHOP TESTS. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and other standard tests for the particular class of equipment, as defined by industry standards.

The transformers shall be subjected to all standard factory tests, including quality control tests. Four certified copies of test results shall be submitted to Engineer before the equipment is shipped to the project site. Temperature tests will not be required, but calculated temperature rise based on tests of similar transformers of the same size shall be furnished.

PART 3 - EXECUTION

3.1 INSTALLATION. The equipment shall be installed in accordance with the drawing specifications and the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Supervision. When indicated, the equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the contract price. Manufacturers' installation supervisor shall observe, instruct, guide, and direct Contractor's erection or installation procedures as required. The equipment manufacturer will be provided with written notification 10 days prior to the need for such services.

3.2.02 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools. The representative shall be present when the equipment is placed in operation. Such services shall be included in the contract price.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3.3 TRAINING

Contractor shall provide training for DWSD employees. Training shall consist of two (2) four-hour sessions and shall include, but not be limited to, racking in and out breakers; setting breakers; using breaker lifting mechanisms; operation of throwover PLC; safety features of switchgear; operation of breakers; operation of meters; preventive maintenance of breakers and switchgear; transformer maintenance; and operation and maintenance of primary switches. Number of trainees, training agenda, topics and days and times shall be coordinated with and preapproved by DWSD prior to start of the training.

End of Section

SECTION 16320

MEDIUM-VOLTAGE THREE PHASE PAD-MOUNTED TRANSFORMERS

PART 1 - GENERAL

1.1 SCOPE. This section covers compartmented, tamper-resistant, weatherproof transformers for mounting on concrete pads. The transformers shall be furnished, installed, and tested as specified herein and as indicated on the drawings. Equipment shall meet the following requirements, and the design conditions and features as indicated.

Transformer equipment shall meet the design conditions and features indicated.

Transformer equipment shall be designated and shall be located as indicated.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer. Minimum clear working space in front of transformers shall conform to NEC Table 110-34(a).

1.2.03 Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

ANSI	American National Standards Institute
AWG	American Wire Gage
FS	Federal Specifications
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.2.05 Governing Standards.

(1) The transformer shall be designed, constructed, and tested in accordance with the latest revision of the applicable IEEE, ANSI, ASTM and NEMA standards except where specific requirements of these specifications conflict with these standards. In such cases, these specifications shall take precedence.

(2) It is assumed that the equipment provided by the manufacturer will be in strict compliance with these specifications unless specific exception is taken and explanation provided.

(3) Current applicable revisions of IEEE, ANSI, ASTM and NEMA standards:

a. C57.12.00 IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
b. C57.12.10 American National Standard for Transformers – 230 kV and Below 833/958 through 8333/10 417 KVA, Single-Phase, and 750/862 through 60 000/80 000/100 000 KVA Three-Phase Without Load Tap Changing; and 3650/4687 through 60,000/80,000/100,000 KVA Three-Phase With Load Tap Changing –Safety Requirements.
c. C57.12.20 American National Standard for Overhead-Type Distribution Transformers.
d. C57.12.70 American National Standard Terminal Markings and Connections for Distribution and Power Transformers.
e. C57.12.90 IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
f. C57.19.01 IEEE Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings

g. C57.91 IEEE Guide for Loading Mineral-Oil-Immersed Transformers (Revision of IEEE Std C57.91-1981, IEEE Std C57.92-1981 & IEEE Std C57.115-1991)
h. C57.98-1993 IEEE Guide for Transformer Impulse Tests.
i. C57.109 IEEE Guide for Liquid-Immersed Transformer through-Fault-Current Duration
j. C 57.119. Recommended Practice for Performing Temperature Rise Tests on Oil Immersed Power Transformers at Loads beyond Nameplate Ratings
k. C57.131. IEEE Standard Requirements for Load Tap Changers
l. C57.13. IEEE Standard Requirements for Instrument Transformers
m. C57.104. IEEE Guide for the Interpretation of Gasses Generated in Oil-Immersed Transformers
n. C57.116. IEEE Guide for Transformers Directly Connected to Generators
o. C57.119. Recommended Practice for Performing Temperature RiseTests on Oil Immersed Power Transformers at Loads beyond Nameplate Ratings
p. C57.120. IEEE Loss Evaluation Guide for Power Transformers and Reactors
q. NEMA Standards Publication TR1 Transformers, Regulators and Reactors
r. ASME, B1.1. American National Standard for Unified Inch ScrewThreads (UN and UNR Thread Form)
s. ASTM, D3487-00 Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
t. ASTM, D5222-00 Standard Guide for High Fire-Point Mineral Electrical Insulating Oils."

The equipment shall also conform to, UL, and NEC 230-95, 240, and 450.

1.2.06 Nameplates. A nameplate with unit description shall be provided on each transformer. Nameplates shall have high black baked enamel 3/4 inch (19 mm) high letters on anodized aluminum.

An instruction nameplate shall be mounted in the low-voltage compartment and shall be readable with cables in place. All doors giving access to high-voltage parts shall be posted with DANGER - HIGH VOLTAGE - KEEP OUT signs. The signs shall be constructed of heavy gage metal, with red letters on a white background.

1.2.07 System Characteristics. The primary side of the transformer will be connected to an electric system with characteristics as indicated on the drawings.

1.3 SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the transformer, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. The drawings and data shall include, but shall not be limited to, the following:

High-Voltage Section

Catalog and data sheets on high-voltage bushings, intermediate lightning arresters, bushing wells, bushing inserts and separable connectors, metal oxide varistor elbow type arresters, load-break switch, tap changer, and fuses.

Fuse time-current characteristic curves.

Transformer

Elevation, plan, weight, and nameplate.

Low-Voltage Section

Catalog and data sheets on low-voltage bushings and terminals, and secondary circuit breakers.

Circuit breaker time-current characteristic curves.

Operation and Maintenance Data and Manuals

1.4 SHIPPING, STORAGE, AND HANDLING. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage, in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked. Complete packing lists and bills of material shall be included with each shipment.

1.5 SPARE PARTS. Spare parts shall be provided based on the spare parts list recommended by the transformer manufacturer or supplier and approved by the client.

Spare parts shall be suitably packaged with labels indicating the contents of each package and shall meet all the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Spare parts shall be delivered to Owner as directed.

1.6 COORDINATION STUDY. When a coordination study of the power distribution system will be conducted in accordance with Master Specification Section 16050, Electrical General Requirements. The equipment manufacturer shall provide the following information to Engineer with the initial equipment shop drawing submittal:

Protective fuse curves for each current-limiting fuse.

Coordination curves for each circuit breaker.

Transformer damage curves and protection evaluated in accordance with ANSI/IEEE C57.109 for each transformer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Each transformer shall be a product of a manufacturer who has supplied such equipment for at least 5 years.

The equipment shall be manufactured by ABB Power T&D, Cooper Power Systems, General Electric, Siemens Energy & Automation, Square D, Waukesha Electric Systems, Reinhausen Manufacturing Inc. for load tap changer or approved equal.

2.2 CONSTRUCTION. Each transformer shall be tamper-resistant and weatherproof, with integral high-voltage and low-voltage compartments, and shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the drawings or specified herein.

2.2.01 Sills and Anchors. The Contractor shall furnish and install steel channels, floor sills, and anchor bolts as required by the equipment manufacturer for proper installation.

2.2.02 Enclosure. The transformer tank and terminal compartments shall be bolted together to form an integral unit of weatherproof construction, suitable for outdoor installation. The transformer shall be completely enclosed, with one high-voltage and one low-voltage compartment door. No externally removable bolts, screws, or other fastening devices shall be used (with the exception of pentahead bolts for security) that provide access to the energized parts within the enclosure. The enclosure shall be of tamper-resistant design.

2.2.03 Terminal Compartments. Full height, air-filled, dead-front incoming and outgoing terminal compartments with hinged doors shall be located side by side, separated by an isolation barrier. The low-voltage compartment shall be on the right when facing the transformer. The fastenings of the high-voltage compartment door shall not be accessible until the low-voltage compartment door has been opened. The low-voltage compartment door shall have a 3-point latching mechanism with vault type handle and provisions for a single padlock. The doors shall be equipped with stainless steel lift-off type pin hinges and doorstops to hold the doors open when working in the compartments. The doorsills shall be removable to permit the transformer to be rolled or skidded into place over conduit stubs. Each compartment shall be suitable for installation of incoming and outgoing cables through the bottom. A tank-grounding pad shall be furnished in each compartment.

2.2.04 Transformer Section. Each transformer shall be 3 phase self cooled less-flammable liquid-insulated, or a self cooled oil-insulated type, as required, with kVA and voltage ratings as indicated on the drawings and as specified herein. Less-flammable liquid shall be fire resistant hydrocarbon type. Transformers with silicone fluid will not be acceptable. The average temperature rise of the windings, measured by resistance, shall not exceed 150°F (65°C) when the transformer is operated at rated kVA output at an average ambient temperature of 85°F (30°C) over 24 hours, with a maximum of 105°F (40°C).

The primary winding shall have four 2-1/2 percent fully rated taps, two above and two below rated voltage. The tap-changer shall be used only when the equipment is de-energized and shall be operated with a hot-stick tool.

The basic impulse level (BIL) of the high-voltage windings shall conform to the following:

Phase to Phase Voltage - kV	BIL Voltage - kV
2.4	45
4.16 & 4.8	60
7.2 & 8.3	75
12.0 through 14.4	95
24.9 delta	150
24.9 wye	125
34.5 delta	200
34.5 wye	150

Transformers shall have the following impedances at their lowest self-cooled ratings:

Transformer Size - kVA	Impedance - percent
75, 112.5, & 225	4.0
300 & 500	4.5
750 & 1000	5.75
1500 & 2000	5.75
2500 & 3000	5.75
3500, 3750, & 5000	6.5
37,500, 50,000, & 62,500	6.5

The transformer tank shall be of sealed construction, with a welded cover. A bolted tamper-resistant handhole shall be provided in the cover for access to internal connections. The tank shall have provisions for installation by lifting, jacking, or rolling into position. The transformer shall be equipped with a liquid level indicator; a pressure relief device; and standard provisions for filling, draining, and sampling.

2.2.05 High-Voltage Terminations. The high-voltage terminations and equipment shall be live-front type conforming to ANSI C57.12.22, or dead-front type conforming to ANSI C57.12.26, as indicated. Three or six terminations shall be furnished as required by the primary distribution system.

2.2.06 Bushings. When live-front type construction is required, bushings shall be porcelain with a 2-hole blade terminal. Bushings shall be externally clamped and front removable. Adequate space shall be provided below the bushings for stress cones on cables. Three intermediate class lightning arresters shall be provided with voltage rating as required.

2.2.07 Bushing Wells. When dead-front type construction is required, bushings shall be either universal bushing wells or one-piece integrated bushings for use with separable connectors. Bushings shall be externally clamped and front removable. Each bushing shall have an adjacent parking stand.

2.2.08 Switches and Fuses. When indicated, primary switches shall be furnished. Switches shall be internal, liquid-immersed two-position or four-position load break type. The size and ratings of the switches shall be as indicated on the drawings.

When bayonet type fuses are indicated, they shall be, liquid-immersed, expulsion fuses accessible through the primary compartment. The fuses shall be removable for external replacement of fuse links using a hot-stick tool without disassembly of the primary cabinet.

When the available short circuit current exceeds the ratings for bayonet type fuses, the fuses provided shall be a combination of internally mounted, liquid-immersed, cartridge fuses (sized approximately 3 times full load primary current) and bayonet type, liquid-immersed, expulsion fuses coordinated to provide full range protection for faults up to 50,000 amperes. The bayonet type fuses shall be removable for external replacement of fuse links using a hot-stick tool without disassembly of the primary cabinet.

2.2.09 Secondary Terminations. When indicated, the secondary terminations shall consist of low-voltage bushings. The bushings shall be of molded epoxy, and shall be provided with blade-type spade terminals with NEMA standard hole spacing arranged for vertical takeoff. The low-voltage neutral shall be an insulated bushing, grounded to the tank by a removable link.

When indicated, one or two molded-case circuit breaker shall be provided in the low-voltage compartment and connected to the low-voltage bushings with a tin-plated copper bus or rigidly supported cable. The circuit breaker and enclosure assembly shall be rated to interrupt and withstand the maximum fault current available from the transformer. The circuit breaker shall have a solid-state trip unit complete with built-in current transformers and flux transfer shunt trip. The ampere rating of the trip rating plug shall be as indicated on the drawings.

The trip unit shall have adjustable short time setting with a fixed instantaneous override for circuit protection. When required, the trip unit shall be provided with additional short delay trip time adjustment for improved system coordination.

When indicated, built-in ground fault protection with adjustable pick-up ratings not exceeding 1200 amperes, time delay adjustable from 0.1 to 0.5 second, and a neutral ground fault current transformer shall be provided.

The breaker shall have built-in test points for testing long delay, instantaneous, and ground fault functions of the breaker by means of a 120 volt ac operated test kit capable of testing breakers 600 amperes and larger.

2.2.10 Shop Painting. All iron and steel surfaces, except stainless steel and machined surfaces, shall be shop painted with the manufacturer's standard coating to a minimum thickness of 3 mils. Finish color shall be ANSI 61 for indoorequipment and ANSI 61 or 70 for outdoor equipment. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup painting of damaged coatings.

When indicated, the underside of equipment installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material.

The coating shall be thick enough to withstand normal handling during shipping and installation. The underside shall be defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting.

2.2.11 Transformer Rating

2.2.11.01 Phases & Frequency: Three @ 60 Hz

2.2.11.02 Capacity HV & LV:
HV Capacity @ 55 Deg C Rise 37.5/50.0/62.5 MVA
HV Capacity @ 65 Deg C Rise 42.0/56.0/70.0 MVA
LV Capacity @ 55 Deg C Rise 37.5/50.0/62.5 MVA
LV Capacity @ 65 Deg C Rise 42.0/56.0/70.0 MVA

2.2.11.03 Cooling Class: ONAN/ONAF/ONAF
KNAN/KNAF/KNAF (Ester Fluids designation)

2.2.11.04 Coolant: Mineral BETA Oil - FR3 per ASTM D3487 Natural Ester Fluid per ASTM D6871-0

2.2.11.05 High Voltage: 120,000 Volts, DELTA connected.

2.2.11.06 High Voltage BIL: 450 KV

2.2.11.07 Low Voltage: 13,800Y/7967_Volts, GND. Y connected.

2.2.11.08 Low Voltage BIL: 110 KV

2.2.11.09 LV Neutral BIL: 110 KV

2.2.11.10 Impedance: 10.5 % @ 37.5 MVA (HV-LV) +/- 7.5%
(9.7-11.3%) @ 42 MVA base with LTC on Neutral and
with 9.8% minimum impedance at any tap.

2.2.11.11 Manufacturer shall state the guaranteed impedance at nominal voltage ratings and ONAN rating with HV DETC @ C (nominal voltage) tap and LV LTC @ Neutral position in the quotation.

2.2.11.12 Impedance tolerance is ± 7.5% for two winding transformers per ANSI C5712.00-2000, paragraph 9.2.

2.2.11.13 De-Energized Taps (DETC) for the primary winding: 2 1/2% steps, 2 above and 2 below rated voltage, full capacity taps. Tap changer for de-energized operation with operating handle brought outside the tank. The operating handle for the de-energized tap changer shall be located at a convenient height for operation by a person standing on the transformer pad, and shall include a position indicator with the highest voltage tap designated as "A".

2.2.11.14 Load Tap changing for the secondary winding: For LTC equipment, refer to Load tap changer, item 2.3.24.

2.2.11.15 Vector Relationship: High voltage shall lead low voltage by 30ºC.

2.2.11.16 Elevation: 3300 Ft or less above sea level and shall be rated for continuous operation at nameplate MVA rating.

2.2.11.17 Ambient temperature: 30°C daily average, 40°C maximum, -20°C minimum.

2.2.12 Transformer Loss Evaluation

2.2.12.01 The guaranteed no-load and load losses shall be stated in the Proposal. An amount in dollars shall be added to the quoted price for loss evaluation according to the following factors:

a. No-Load Losses @ 20ºC $_____/kW

b. Load Losses @ 75ºC $ _____/kW at 37.5 MVA

c. Auxiliary Losses $______/kW at 37.5MVA

2.2.12.02 Reported losses shall use IEEE reference temperatures of 20°C for No Load Losses and 75°C for Full Load Losses.

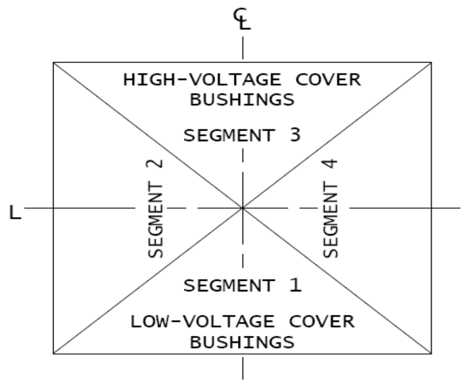
2.2.12.03 Test system accuracy must be verified for conformance with the current revision requirements of IEEE C57.12.00.

2.2.12.04 The proposal shall include documentation, which verifies the accuracy of the loss measurement system. Documentation provided with the quotation shall include sufficient identification of the test system to enable the owner to confirm that it is the same system used to test the transformer

2.3 ACCESSORIES.

2.3.01 Special Tools and Accessories. The transformer shall be equipped all accessories and shall be located as required by latest revision of ANSI Standard C57.12.10 below including:

ANSI C57.12.10-1997



Accessories	Locations	Section
Tap-changer operating handle	S1, S4, See Ref	5.1.1
*Liquid-level indicator	S1	5.1.2
*Liquid-temperature indicator	S1	5.1.3
Drain and filter valves	S1	5.1.5
Nameplate	S1	5.4
*Pressure-vacuum gauge	S1	5.1.4
Jacking facilities	See Ref	5.3.4
Ground pad(s)	See Ref	5.5
†Load-tap-changing equipment	S1 or S2	6
†Auxiliary cooling control	S1 or S2	5.9

*Not furnished for transformers with distribution BIL characteristics 200 kV and below.
†When furnished.

NOTE—Some designs include accessories and wiring connections as part of the load-tap-changing equipment assembly. When this is the case, accessories may be located in the same segment as the load tap changer and may be viewed parallel to the segment centerline.

Figure 1 – Accessories

2.3.01.01 Hot-Stick Tool. When indicated, an insulated hand-held epoxy fiberglass tool shall be furnished with the transformer. The tool shall have a retracted length of less than 5 feet (1.5 m), extended lengths of 8 and 12 feet (2.4 and 3.6 m), and shall have a disconnect type head. The tool shall be manufactured and tested according to OSHA specifications.

2.3.02 Magnetic liquid level indicator with form "C" alarm contacts. Indicators shall have minimum 6” diameter dials.

2.3.03 Top Liquid temperature indicator shall be designed with a capillary tube for remote mounting of the indicator dial at a height within 6 feet of the base for convenience when reading the temperature and resetting the drag hands while standing on the transformer foundation. With form "C" alarm contacts the indicator shall have minimum 6” diameter dials.

2.3.04 Winding hot spot temperature indicator shall be designed with an electronic gauge that can perform all the heat load calculations and control the cooling groups. Recommended system is MTec-EPT202 from Messko or approved equal.

2.3.05 Drain valve and the oil sampling valve, located to allow complete draining or sampling from the bottom of the tank.

2.3.06 Cover-mounted mechanical pressure relief device with automatic resealing operation, form "C" alarm contacts and mechanical signal for indication of device operation.

2.3.07 Fault Pressure Relay (Mounted below the oil level to monitor the liquid pressure).

2.3.07.01 The relay shall be sensitive to the rate of pressure increase and consisting of 120 volts (AC/DC) form "C" contact wired to identified terminal points in the main control cabinet and shall be suitable for use in the transformer protection scheme.

2.3.07.02 The relay shall be installed on the valve near the bottom of the transformer and monitor the pressure of the oil.

2.3.08 Future Monitoring Provisions.
The transformer shall be provided with the following for future addition of monitoring equipment including:

2.3.08.01 On line DGA monitors.
This would include the addition of two sampling valves, one near the top oil/top winding and the second near the bottom winding/ about 1-2 feet above the base. For best results, the sampling shall be in the active oil flow between the cooling/radiators and windings to provide the sampling in the active oil stream.

2.3.08.02 Additional thermal wells for future addition of thermal digital monitoring systems for the top oil, HV, LV and TV winding temperature monitoring.

2.3.08.03 One oil level gauge set for critical oil level (minimum oil level for energized operation).

2.3.08.04 Additional space in the transformer control cabinet for supplying power to these devices and bringing the outputs back to the control cabinet for customer convenience for wiring from the transformer by the customer.

2.3.09 A minimum of two circular, bolted manhole covers with raised flanges shall be provided.

2.3.09.01 They shall be located such that they are accessible without the removal of any other equipment.

2.3.09.02 Manholes shall be constructed with flush handles to reduce tripping hazard when working on the transformer cover.

2.3.10 Core grounds:

2.3.10.01 Cores shall be grounded at only one point and the core grounds for both the main and series transformer shall be brought to a convenient location for testing and be brought out on the cover through bushings and grounded externally. Core ground bushing(s) shall be enclosed.

2.3.10.02 Core grounds for series transformer or preventive auto transformers shall also be brought out for testing when applicable.

2.3.11 Provide a device suitable for mounting a safety device in the approximate center of the tank cover to be capable of supporting the hardware including harnesses utilizing gravity brakes.

2.3.12 Radiators:

2.3.12.01 Removable radiators will be supplied with individual shut-off valves at each tank connection. Each radiator will be supplied with means for draining and venting.

2.3.12.02 Radiators shall be constructed to withstand tank operating pressure and full vacuum.

2.3.12.04 All radiators shall be interchangeable.

2.3.12.05 All fans shall have galvanized fan guards and be provided with one-piece fan blades.

2.3.12.06 Radiators shall be hot dipped galvanized.

2.3.13 Jacking and moving provisions including:

2.3.13.01 Lifting lugs for lifting complete oil filled transformers.

2.3.13.02 Lifting eyes for lifting the cover only.

2.3.13.03 Facilities for lifting core and coil assembly from tank.

2.3.13.04 Jacking facilities at four corners of the base.

2.3.14 Nameplates

2.3.14.01 Transformer nameplate shall meet the requirements of IEEE C57.12.00.

2.3.14.02 For LTC transformers, the transformer nameplate shall also include the booster ratio data when applicable.

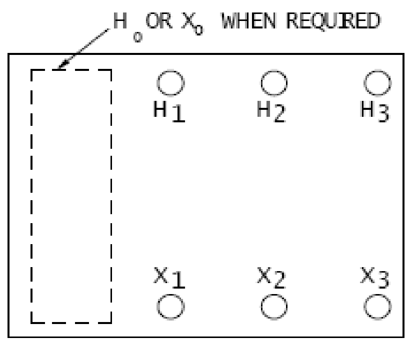
2.3.14.03 Diagrammatic engraved stainless steel nameplate for both the transformer and load tap changer. Information provided on the nameplate shall be included with the bid documents.

2.3.14.04 Load Tap Changer nameplate shall include the following information:

a. Manufacturer of the mechanism.
b. Model number of the mechanism.

c. Year of Manufacture.
d. Maximum rated through current of the mechanism.
e. Type of transition impedance, resistor or reactor.
f. Method of arc interruption (Type of Mechanism)
g. Type of drive mechanism, energy spring or direct
h. Amount of oil in the mechanism compartment.

2.3.15 Bushings:
Bushings shall be cover mounted and installed per ANSI, C57.12.10. Refer to figure2 below:



High voltage line bushings will be located on the transformer cover in IEEE Segment 3 and shall be rated 800 Amperes, 138 kV, 650 kV BIL.

2.3.15.01 Low voltage line bushings will be located on the transformer cover in ANSI Segment 1 and shall be rated 4000 Amperes, 25KV, 150 KV BIL.

2.3.15.02 Low voltage neutral bushing will be located on the transformer cover in ANSI Segment 2 with a flange for bus duct connection and shall be rated 4000 Amperes, 25 KV, 150 KV BIL.

2.3.15.03 Low Voltage Neutral Bushings shall be same rating as Low Voltage line bushings.

2.3.15.04 All bushings shall be Sky Gray (ANSI 70) and shall have provisions for power factor testing. Bushings shall be oil-filled condenser type.

2.3.15.05 The transformer shall be equipped with a ground pad on the cover for grounding the LV neutral bushings.

2.3.15.06 LV neutral bushing shall be grounded to the ground pad on the transformer cover with a removable link for testing

2.3.15.07 A ground cable shall be installed from the cover ground pad to a ground pad at the base of the transformer.

2.3.16 Surge Arresters:
Metal-oxide station type transformer mounted surge arresters shall be provided as follows.

2.3.16.01 Three (3) 138 KV, 84 KV MCOV surge arresters mounted near and connected to the high voltage bushings.

2.3.16.02 Three (3) 15 KV, 9 KV MCOV surge arresters mounted near and connected to the low voltage bushings.

2.3.16.03 The transformer shall be equipped with ground cables for connection of high and low voltage surge arresters to the ground pad(s) at the base of the transformer.

2.3.16.04 Porcelain shall be ANSI 70 Sky Gray. Arresters shall meet the requirements of ANSI C62.1.

2.3.17 Current Transformers
Multi-ratio bushing type current transformers for relaying service shall be furnished as described below:

2.3.17.01 Each high voltage bushing with Qty 2, 600 /5 MR, with accuracy of C400.

2.3.17.02 Each low voltage bushing as shown on the one line.

2.3.17.3 Low voltage neutral bushing with Qty 1, 600/5 MR, with accuracy of C 400.

2.3.17.4 All Current Transformers shall have fully distributed windings and a minimum Thermal Rating Factor of 2.0

2.3.18 Electrical Design:

2.3.18.01 The transformer, including all core and coil assemblies, shall be power class, round core/circular coil design and construction. High voltage and low voltage windings for the main core/coil assembly shall be either disk or helical construction layer/barrel windings are not acceptable. All windings shall be copper conductor and either rectangular magnet wire or continuously transposed cable.

2.3.18.02 The owner reserves the right to inspect the completed core and coil assembly prior to tanking. The manufacturer shall notify the owner not less than five days prior to the date of tanking to allow the owner to witness tanking, if so desired.

2.3.18.03 The transformer design shall be adequate to withstand short circuits with the fault current limited only by the impedance of the transformer itself. Short circuit withstand shall be calculated utilizing Finite Element Analysis (FEA) and shall consider all combinations of DETC and LTC tap positions for single line to ground faults, double line to ground faults, line to line faults and other fault conditions to determine the tap position combination resulting in the highest stresses for transformer windings.

2.3.18.04 The regulating winding for the load tap changer shall be fully distributed and be electrically independent from or placed on a separate winding tube from the high and low voltage windings.

2.3.18.05 Internal surge arresters or non-linear resistors shall not be included as part of the internal insulation system, unless written authorization is first obtained from the owner.

2.3.18.06 Insulation on all conductors used in the coil winding process (except CTC) copper conductors shall be cellulose insulating paper suitable for a minimum of 65°C rise continuous operation.It shall be wound onto the conductor employing a spinning process. The paper insulation shall be applied in single or multiple strands such that a minimum of 30% of the paper surfaces are overlapped to provide for a continuous insulating surface. Sufficient tension shall be maintained on the paper strands so as to prevent loose wraps. If clamping rings are utilized in the transformer design, full circumference rings shall be used. Core and coils shall be dried using a “vapor phase” system prior to filling.

2.3.19 Cooling Equipment and Controls

2.3.19.01 Cooling equipment shall be furnished as required to provide the transformer's rated capacity without exceeding the guaranteed temperature rise.

2.3.19.02 Forced cooling capacity shall be provided by the use of fans for forced air cooling. Temperature control shall be provided by the winding temperature equipment, including a temperature indicator and relay contacts to automatically actuate forced cooling equipment in proportion to the transformer load.

2.3.19.03 Cooling equipment motors shall be rated for service on a 120/240 volt, single-phase power supply.

2.3.19.04 Control circuit devices shall be rated 120 volt single phase.

2.3.19.05 Alarm circuit devices shall be rated for 120 volts AC/DC for SCADA interface.

2.3.19.06 Manual control switches shall be provided in the control cabinet to allow testing and maintenance of the cooling fans, and to enable selection of which group of fans is used for the first forced cooled stage.

2.3.19.07 Transformer cooling equipment shall be designed for a continuous self-cooled and maximum force-cooled operation.

2.3.20 Mechanical Construction

2.3.20.01 The tank and radiators shall be fabricated from steel with sufficient strength to withstand normal service stresses without distortion or damage.

2.3.20.02 The tank shall be designed to withstand an internal operating pressure of 8 psi with margin for a minimum of 25% over pressure, and full vacuum. All joints in the tank and radiators shall be made oil tight and gas tight by welding inside and outside.

2.3.20.03 All tank seams shall be double welded (inside and outside) and shall be a minimum of six (6) inches from the corner. Corner welds are not acceptable.

2.3.20.04 Cover shall be domed to shed water and welded to the tank. During welding of the transformer cover, an inorganic gasket will be permanently located between the cover and the tank flange to prevent the entrance of weld spatter into the tank.

2.3.20.05 All gasketed openings shall be designed with means provided for controlled compression of the gasket, utilizing metal-to-metal stops, and re-usable gaskets of an oil resistant material. All gasketed joints on top of the transformer shall utilize flanges, which are raised at least 3/4 inch above the cover surface.

2.3.20.06 All external tank supports or stiffeners shall be box beam construction and continuously welded.

2.3.20.07 Paint:

a. Transformer tank and all auxiliary equipment shall be painted with a rust-inhibiting primer and top coat to provide a minimum 3 mil dry film thickness. External paint color shall be Sky Gray, ANSI 70.

b. Inside of main tank and LTC compartment shall be painted white.

c. Accelerated aging test must be performed on the paint to be used inside the tank. A plate steel sample coated with the white paint shall be submerged in the transformer insulating oil and heated to 130 degrees C. After 1,000 hours, there may not be any change in the painted surface, or in the power factor of the oil used for the test.

d. The top of the main tank and LTC compartment shall be provided with a non-skid coating.

2.3.21 Insulating Fluids

2.3.21.01 Mineral Oil:

A sufficient quantity of inhibited mineral oil shall be furnished for the transformer to fill it to the normal operating level. The insulating liquid shall meet all requirements as defined by ANSI Standards, shall be chemically stable, free from acidity or other corrosive ingredients, and shall be certified "Non-PCB" in accordance with current EPA Regulations.

2.3.21.02 Natural Ester Fluid:

A sufficient quantity of natural ester fluid shall be furnished for the transformer to fill it to the normal operating level. The insulating liquid shall meet all requirements as defined by ANSI Standards, shall be chemically stable, free from acidity or other corrosive ingredients.

2.3.22 Oil Preservation Systems:

The transformer shall be equipped with a nitrogen inert-gas oil preservation system. The nitrogen for use with inert-gas-protected transformers shall be in accordance with ASTM D1933-1997. The nitrogen shall be supplied in 200 ft^3 cylinders equipped with Connection No 580 of ANSI/CGA-V-1-1994. The filling pressure shall be 2200 $lbs/in.^2$ at 70°F.

2.3.23 Auxiliary Power and Control Circuits:

2.3.23.01 All auxiliary power and control circuits which are supplied for connection to external circuits shall be brought to suitable terminal blocks located in a common, weather-resistant, NEMA 3R control cabinet. All contacts on auxiliary devices shall be wired to terminal blocks in the same cabinet for owner's use. Terminal blocks shall be with washer head binding screws and white circuit identification marking strips. Shorting type terminal blocks shall be used on current transformer leads.

2.3.23.02 Cabinet shall be equipped with a stainless steel 3-point latching mechanism, and a continuous stainless steel hinge.

2.3.23.03 All welds on all enclosures shall be continuous to prevent moisture entrance.

2.3.23.04 Wire for control and power circuits shall be rated for use in conduits as well as cabinets, and shall utilize insulation which is both fire resistant and resistant to transformer insulating oil.

2.3.24 Load Tap Changer

2.3.24.01 The transformer shall be complete with a load tap changer having a range of 10 percent above and 10 percent below normal voltage in 32 equal 5/8 per cent steps. The Load Tap Changer shall meet the requirements of IEEE Std. C57-131-1995 IEEE Standard Requirements for Load Tap Changers.

2.3.24.02 The tap changer shall be able to deliver full rated KVA on tap positions above rated voltage and rated current and on tap positions below rated voltage.

2.3.24.03 The LTC shall be Constant Flux Voltage Variation connected to regulate the low voltage winding.

2.3.24.04 The LTC mechanism shall be High Speed Resistive Waukesha Electric UZD or ABB UZE or Vacuum Reactance Reinhausen RMV-II (2,500A – 15KV) and designed for 1M electrical and mechanical operations before contact or vacuum bottle replacement is required. A contact life curve for the load tap changer being provided shall be supplied with the bid documents. The Tap changer shall be supplied with the maintenance free package stipulating (1 million operations of life span) and a 5-year warranty.

2.3.24.05 If the tap changing system quoted requires a preventive autotransformer or a series transformer, they shall be power class, round core/coil design, disc or helical type winding design and construction, and all winding conductors shall be copper.

2.3.24.06 The tap changer mechanism shall be mounted in a separate oil filled compartment, capable of withstanding full vacuum in the main tank, without the use of bypass piping and equipped with:

a. Liquid level gauge with alarm contacts.
b. Pressure control switch with trip contacts.
c. Cover mounted mechanical pressure relief device. The pressure relief device mechanism including micro switches must be fully protected by a cover featuring lateral openings for transformer tank and OLTC. A yellow semaphore for visual indication shall be provided. The trip contacts (insulation IP65) must be directly activated by a self-locking red signal pin. Utilized spring steel corresponds to class1 according EN 10270-1 and are synthetic coated according DIN2095. Device release time must be within 2ms. All important parts like trip contacts, springs, must be mounted inside the protective cover. All material must be rated for salt water and corrosive environment operation. Approved devices are the Reinhausen-Messko MPreC.
d. Drain valve with sampling device.

e. Filling plug located at the top of the compartment.

f. LTC tank bottom shall be sloped to drain oil away from the door.

2.3.24.07 The load tap changer mechanism shall be equipped with a motor drive unit. The motor drive shall be supplied by the LTC manufacturer and completely wired and tested at their facility. The approved drive shall be Reinhausen, MD-11 and shall include:

a. Automatic voltage regulation regulator (AVR) shall be wired and mounted in the motor drive by the LTC manufacturer. The approved voltage Controllers are the ReinhausenTAPCON250. If required, it shall include menu selectable paralleling capabilities via either the master/follower or minimum circulating current methods.

b. The paralleling mode shall be able to operate up to 16 individual transformers.

c. The communication between paralleling transformers shall be via CAN Bus technology and uses a three wire shielded conductor cable.

d. In addition the AVR shall be capable of taking a position signal from the LTC motor drive, relaying this information on its display and provide an active remote position analog output for customer's use.

e. If necessary, provision for SCADA communication via preferred method (DNP 3.0, Ethernet, RTU, etc.) as well as fiber optic capability shall be easily adaptable to the unit.

2.3.24.08 The cover on the oil filled compartment, regardless of weight of the cover, shall be hinged to support itself when open.

2.3.24.09 The manufacturer shall include (in the main transformer tank) a current transformer for input to the line drop compensator. The owner will provide a potential source for operating the voltage regulating relay, which will consist of one line to ground potential transformer on X1 and X0 with a secondary voltage of 120 volts.

2.3.24.10 The following equipment shall be supplied, and mounted in a cabinet attached to the transformer tank:

2.3.24.10.01 Static voltage regulating relay equipped with

a. Line drop compensator with resistance and reactance adjustments.

b. Reactance reversing switch.

c. Provision for manual operation.

2.3.24.10.02 If the load tap changer operation sequence is susceptible to interruption and consequently can be stopped in the “off-tap” position, the preventive autotransformer shall be designed to carry the maximum current available in the “off-tap” position indefinitely. The transformer shall also be equipped with an alarm to be activated if the “off-tap” position occurs.

2.3.24.10.03 Automatic-manual selector switch.

2.3.24.10.04 Raise and lower switches for manual operation.

2.3.24.10.05 Motor and controls protected by circuit breakers.

2.3.24.10.06 Voltage testing terminals.

2.3.24.10.07 Space for mounting equipment for parallel operation by the circulating current method.

2.3.24.10.08 Control compartment heater with switch.

2.3.24.10.09 Terminal board in control compartment for termination of control and wiring.

2.3.24.10.10. Drill plate in bottom of cabinet for attachment of owner's conduit.

2.3.24.10.11. The drive mechanism shall be designed such that the load tap changer can be manually operated, while energized under full load, safely with no potential harm to the operator or transformer.

2.3.24.10.12. If the drive mechanism can be stalled in the "off-tap" position, it shall be designed to include an alarm with remote contacts and be capable of maintaining full load indefinitely.

2.3.24.10.13. A self-regenerating microprocessor controlled maintenance free dehydrating breather shall be supplied for the LTC compartment and the transformer conservator. The breather shall include humidity and temperature sensors and a test button to verify the electronic circuit. LEDs for device status indication shall be provided as well as a space heater in the control box to prevent condensation of moisture. Breathers for transformer application shall feature the BETA control software, designed to allow regeneration only when the transformer is breathing out. In addition error and status relays shall be provided for remote indications. A 4-20mA output for remote temperature indication shall be available. The breather shall be installed with a ¼” isolation valve and on an installation pad welded on the OLTC and transformer wall. Based on climatic circumstances, an output filter heater should be installed to prevent formation of ice. Approved devices are Reinhausen-Messko MTraB.

2.3.24.10.14 LTC performance shall be based on entire range of operations (+/-16) and maximum nameplate rating unless otherwise specified by the owner.

2.4 SHOP TESTS.

2.4.01 All routine tests listed in ANSI C57.12.00 for class II substation power transformers plus additional tests as specified herein, are required. All tests shall have the physical voltages induced. No voltage simulation tests shall be allowed for testing the transformer windings.

2.4.01.01 Class II testing including:

2.4.01.01.01 Winding insulation resistance

2.4.01.01.02 Core insulation resistance

2.4.01.01.03 Insulation Power factor

2.4.01.01.04 Control (auxiliary) cooling losses

2.4.01.01.05 No Load losses and exciting current @ 100 and 110%

2.4.01.01.06 Dielectric Tests:

2.4.01.01.06.01 Low frequency testing including 1 hour induced test with partial discharge measurements

2.4.01.01.06.02 Low frequency on auxiliary devices control and current transformer circuits

2.4.01.01.06.03 Lightning Impulse

2.4.01.01.06.04 Dissolved gasses in oil

2.4.01.02 Optional factory tests:

2.4.01.02.01 Zero Sequence impedance tests

2.4.01.02.02 Temperature rise

2.4.01.02.03 Time Constant heat runs

2.4.01.02.04 Overload heat runs

2.4.01.02.05 Audible Sound level

2.4.01.03 Baselines for field acceptance test data including:

2.4.01.3.01 Single phase excitation tests

2.4.01.03.02 10 kV leakage reactance tests

2.4.02 Five certified copies of the certified test report shall be delivered to the owner's representative on site after completion of all factory tests.

2.4.03 Insulation power factor tests shall be performed on all winding-to-winding-to-ground insulation. Measured values exceeding 0.5% (corrected to 20 C) will not be accepted.

2.4.04 The owner reserves the right to request through-fault testing (at extra cost) at any time prior to final testing of assembled unit.

2.4.05 The owner reserves the right to witness testing. The manufacturer shall notify the owner of the performance dates for all tests not less than five days prior to the date of a test to allow the owner to witness testing if so desired. Refer to item 2.6

2.4.06 The manufacturer shall notify the owner of any unusual event or damage occurring during the fabrication of the transformer and of all tests which do not meet the specified or guaranteed values. The owner reserves the right to inspect such damages or test failures. Corrective measures to overcome such damage or failure shall be reviewed with the Owner.

2.4.07 Manufacturer shall provide all the information necessary to perform Arc Flash study analysis by others.

2.5 SHIPPING REQUIREMENTS

2.5.01 The manufacturer is responsible to ship the transformer F.O.B destination.

2.5.02 For truck shipment the destination shall be the substation site.

2.5.03 For rail shipment the destination shall be the rail siding nearest to the substation site to which the manufacturer can obtain clearance for shipment.

2.5.04 The transformer shall be shipped from the factory without oil-filled radiators.

2.5.05 Electronic Impact recorders with GPS technology for shipment tracking and on line reporting of shipping progress shall be provided with any rail shipped equipment. The manufacturer shall mount them at the factory to provide a permanent record of the magnitude of axial, transverse and vertical forces to which the equipment will be subjected while in transit. The impact recorders shall be returned to the manufacturer.

2.5.06 Fans shall be mounted on and shipped with appropriate radiator bank(s).

2.6 WITNESS TESTING.
The general contractor shall arrange for witness testing at the factory with the transformer manufacturer and coordinate with the client the number of people that will be attending the test. The selected individuals shall submit their report at the end of the testing period to the acting project manager.

PART 3 - EXECUTION

3.1 INSTALLATION. The transformer shall be installed in accordance with drawings, specifications, and manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting conduit or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price for the number of days and round trips to the site as required.

End of Section

SECTION 16345

MEDIUM-VOLTAGE METAL-CLAD SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE. This section covers medium-voltage metal-clad switchgear that shall be furnished and installed as specified herein and as indicated on the drawings.

Switchgear shall meet the design conditions and features as indicated.

Switchgear shall be designated and shall be located as indicated on the drawings.

1.2 GENERAL. Equipment furnished under this section shall be fabricated, assembled and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1.2.03 Workmanship and Materials. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
AWG	American Wire Gage
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.2.05 Governing Standards. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the applicable standards of ANSI, NEMA and IEEE, including, but not limited to; IEEE C37.04, C37.06, C37.11, C37.20.2, C37.09, and C57.13; and NEMA SG-4 and SG-5.

Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

1.2.06 Nameplates. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors and rear cover plates. Nameplates shall have 3/4 inch (19 mm) high letters for section identity and 1/8 inch (3 mm) letters for other information black baked enamel letters on anodized aluminum plate.

Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1.2.07 System Characteristics. The switchgear will be connected to a power system with characteristics as indicated on the drawings.

1.2.08 Rating. The metal-clad switchgear assembly shall be rated as indicated.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the switchgear, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data shall include, but shall not be limited to, the following:

Master drawing index.

Front view elevation.

Floor plan.

Top view.

Conduit entry/exit locations.

Weight.

Bill of materials.

Single line diagram.

Three line diagram.

Schematic diagram.

Nameplate schedules.

Assembly ratings including short circuit rating, voltage, continuous current, and basic impulse level.

Major component ratings including voltage, continuous current, interrupting rating.

Cable terminal sizes.

Descriptive bulletins.

Product data sheets.

Seismic certification, when required.

When a power company metering compartment is specified, drawings and details pertaining to each utility metering section shall be subject to the approval of the electric utility company in addition to review by Engineer.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Assembly, installation, alignment, adjustment anchorage, and checking instructions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 SHIPPING, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.4.01 Preparation for Shipment. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

1.5 SPARE PARTS. Spare parts shall be suitably packaged, with labels indicating the contents of each package and shall meet all the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Spare parts shall be delivered to Owner as directed.

A complete set of spare power and control fuses, indicating lamps, and indicating color caps shall be provided for each section of switchgear.

1.6 COORDINATION STUDY. When indicated, a coordination study of the power distribution system will be conducted as specified in Master Specification Section 16050, Electrical General Requirements.

The initial equipment drawing submittal shall include the protective relay time-current curves for each relay provided as a part of the medium-voltage switchgear assembly.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. The switchgear shall be manufactured by Cutler-Hammer, General Electric, Siemens Energy & Automation, Square D, or approved equal.

2.2 CONSTRUCTION. All equipment furnished under this section shall be designed and constructed in accordance with the following requirements. The switchgear shall be the product of a manufacturer of both the stationary and draw out elements of a complete power circuit breaker assembly.

2.2.01 Sills and Anchors. Contractor shall furnish sills for all switchgear that requires sills to be embedded in the floor for leveling and alignment. The sills shall be drilled and tapped as required. All equipment requiring anchor bolts shall be provided with the anchor materials, complete with bolts, nuts, and washers. Sills and anchor materials shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed. Equipment drawings shall show sill and anchor bolt locations.

2.2.02 Enclosure. The type of switchgear enclosure shall be as indicated. The enclosure shall contain circuit breakers and all necessary accessory components. The integrated switchgear assembly shall withstand the effects of closing, carrying, and interrupting currents up to the assigned short circuit rating.

Outdoor non-walk-in switchgear shall have individual weatherproof doors on the breaker draw out side of each switchgear section. A 120 volt light with a switch and a service receptacle shall be mounted behind each door.

Outdoor walk-in switchgear shall have a sheltered operating and maintenance aisle, large enough to permit interchange of breakers, along the full length on the draw out side of the switchgear. A weatherproof door with an outside lock and an inside quick-release latch mechanism, to permit opening the door from the inside even when locked from the outside, shall be provided on each end. All maintenance aisles shall be provided with light fixtures rated for 120 volts ac, with three-way light switches at each door. The lights shall provide 75 foot-candles (807 lux) of general illumination. A 120 volt grounding type duplex receptacle shall be provided at each end of the aisle.

Electric unit heaters with thermostats shall be furnished to maintain a temperature of at least 40°F (4°C) in the aisle under the outdoor temperature and the relative humidity design conditions as required.

When indicated, a ventilating system consisting of fans with manual-automatic thermostats, intake louvers with screens and filters, two-position open-close control dampers, and electric damper operators shall be furnished in the aisle to provide 12 air changes per hour. Power supply to the ventilating system will be 120 V ac.

All outdoor type switchgear shall be provided with weathertight gasketing on all exterior doors, removable covers, and panels.

Switchgear lights, receptacles, heaters and fans shall be served by either an integrally installed auxiliary power source or an external auxiliary power source as indicated on the Contract Documents.

Adequate bracing shall be provided for seismic forces.

2.2.03 Vertical Sections. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted together to form a rigid metal-clad switchgear assembly. Each vertical section shall accommodate breakers stacked two high and auxiliaries four high. Metal side sheets shall serve as grounded barriers between adjacent structures. Solid removable metal barriers shall isolate the primary major sections of each circuit. Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling.

2.2.04 Space Heaters. When indicated, each switchgear compartment shall be equipped with a space heater of adequate capacity to prevent moisture condensation within the switchgear. The heaters shall be thermally insulated and located at a safe distance from painted surfaces. Each space heater shall be rated for double the applied voltage. The heaters shall be controlled by an adjustable thermostat set to cut out when the temperature rises to 90°F (32°C) and to cut in when the temperature falls below 85°F (29°C). Each space heater shall be equipped with a disconnect switch.

A space heater power bus shall be provided throughout the switchgear to power the space heaters. When indicated, the bus shall be served by an integrally installed auxiliary power source.

2.2.05 <u>Circuit Breakers</u>. The circuit breakers shall be three-pole, single-throw, and shall be furnished complete with all equipment on a draw out carriage. The breakers shall be operated by a stored energy mechanism consisting of a heavy-duty spring, charged normally by a universal electric motor, and, in an emergency, by a manual handle. The circuit breaker control voltage shall be as indicated. For ac operation, the capacitance trip device shall be of the type that retains tripping power for at least 48 hours after loss of control power.

Each circuit breaker shall contain three vacuum interrupters, separately mounted in a self-contained, self-aligning housing which can be removed as a complete unit. The vacuum interrupter pole unit shall be mounted on glass polyester supports. Each vacuum interrupter shall be provided with a contact wear gap indicator which requires no tools to indicate available contact life, and is easily visible when the breaker is withdrawn on the extension rails. For ease of inspection and maintenance, the breaker front panel shall be removable when the breaker is withdrawn.

Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from the housing, and to discharge the stored energy mechanism upon insertion or removal from the housing. The breaker shall be secured positively in the housing between, and including, the operating and test positions.

All removable breaker units of the same type and ampere capacity shall be wired alike and shall be electrically and mechanically interchangeable.

2.2.06 <u>Main Bus</u>. The main bus shall consist of rigidly supported, tin-plated copper bars of suitable design and cross-sectional area to satisfactorily carry the rated current without exceeding the specified temperature rise.

The bus shall have insulation, bus joint covers, and supports of molded epoxy that is nontracing, nonflammable, and nonhygroscopic. Bus supports shall be glass polyester inserts. The bus shall be capable of withstanding the magnetic forces imposed by short-circuit currents equal to the close and latch rating of the largest circuit breakers.

The bus insulation shall be of molded epoxy material over the entire length and shall be designed for the voltage service as required. The bus insulation shall be able to withstand the ANSI standard 60 Hz full wave and impulse (1-1/2 x 40 microseconds) test voltages of 19 and 60 kV or 36 and 90 kV as indicated. The molded epoxy insulation shall have a high resistance conducting surface in contact with the bus to eliminate corona damage to the bus insulation.

The current-carrying capacity shall be based on actual service conditions, including skin and proximity effect, insulation, steel enclosure, and an ambient temperature of 105°F (40°C). The bus shall be derated in accordance with NEMA SG-5 for ambient temperatures higher than 105°F (40°C). The bus shall be supplied in unit lengths that will permit the reassembly of the units in the field.

All joints shall have tin-to-tin contact surfaces and minimum contact resistance. Joints shall be equipped with removable insulating fittings at least equal to the bus bar insulation.

To prevent undesirable or destructive mechanical strains in the bus supports and connections, provisions shall be made for bus expansion through an ambient temperature range of -22°F to 120°F (-30°C to +50°C). Expansion joints shall be supplied as necessary.

2.2.07 Ground Bus. An uninsulated ground bus of tin-plated high conductivity copper, with momentary and short time ratings at least equal to those of the largest circuit breaker, shall be furnished through the entire length of the switchgear. All switchgear equipment requiring grounding shall be connected to this ground bus. A clamp type connector shall be provided on each end of the ground bus for external connection of a 500 kcmil (240 mm^2) stranded copper grounding cable to the grounding system. A clamp type connector shall also be provided in each vertical section for connection of stranded copper grounding cable run with incoming and outgoing phase wires, as indicated on the drawings.

2.2.08 Neutral Bus. When required, a fully-rated insulated ground bus of tin-plated high conductivity copper, with momentary and short time ratings at least equal to those of the largest circuit breaker, shall be furnished through the entire length of the switchgear. All switchgear equipment requiring a neutral shall be connected to this neutral bus.

2.2.09 Auxiliary Contacts. Each breaker shall be furnished with a sufficient number of auxiliary contacts and auxiliary switch contacts to provide all necessary interlocks for proper operation of the equipment. Not less than two spare NO and two spare NC auxiliary contacts shall be furnished on each breaker. In addition, mechanically operated auxiliary switches mounted in the stationary switchgear housing shall be provided with not less than two spare NO and two spare NC contacts. All auxiliary contacts and auxiliary switch contacts, including spare contacts, shall be wired to terminal blocks for use with control circuits.

2.2.10 Bus Connections. All current-carrying connections to the main buses shall be insulated copper of suitable capacity and shall conform to the requirements of the main bus insofar as bracing and temperature limits are concerned. Stationary contacts for the circuit breaker connections shall be suitable for the particular service.

Connections to the bus shall be made with suitable bus clamps or bolts with lock washers, and the copper bars shall be tin-plated at current-carrying connections. Molded removable covers or similar devices shall be used at connections to the bus.

Connections from the current transformers shall permit the transformers to be easily replaced.

Insulated cable connections shall be furnished for the potential transformers and control power transformers.

All materials required for insulation of field connections and their associated bus and terminals shall be provided.

2.2.11 Current Transformers. Ring type or toroidal current transformers of ANSI standard relay accuracy shall be furnished as indicated herein, as indicated on the drawings, and as verified by the coordination study. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. The standard arrangement of two current transformers on the bus side and two on the line side of the breaker units shall be front accessible to permit adding or changing the current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all current transformers.

When indicated, current transformers rated 600 amperes and smaller shall be of the wound type, with tin-plated primary terminals and insulated to withstand ANSI standard test voltages for the switchgear. The accuracy of these current transformers shall be suitable for the meters and relays specified with the normal burdens of the various devices, and not less than ANSI standard accuracy classification of 0.3 with burdens B-0.1 and B-0.5, and 1.2 with burden B-2.0.

2.2.12 Potential and Control Power Transformers. Potential and control power transformers shall be supplied in the quantities and of the ratings specified herein or indicated on the drawings. Potential or control power transformers up to 15 kVA single phase shall be mounted in a drawer or a tilt-out carriage in an auxiliary compartment. Opening the drawer shall ground the primary fuses of the transformer and permit easy inspection, testing, and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

The instrument potential transformer rating shall be coordinated with the instruments, relays, meters, and devices specified. The transformers shall have a mechanical rating equal to the momentary rating of the circuit breakers and shall have metering and relaying accuracies conforming to ANSI standards. The primary fuses furnished with the transformers shall be current-limiting type and shall be rated approximately 1/2 ampere. The fuses shall clear a faulted transformer in approximately 1/2 cycle (on 60 Hz basis), but shall not blow on magnetizing inrush current nor protect a transformer with a shorted secondary. Secondary fuses shall be provided for protection of potential transformers.

A mechanical interlock shall be provided for control power transformers, to require the secondary breaker to open before the drawer can be withdrawn.

2.2.13 Control Devices. Control switches shall be 600 volt, 20 ampere, multistage rotary type with black handles. Each switch shall have a fixed pistol grip handle with an engraved black plastic escutcheon plate. All circuit breaker control switches mounted on the front instrument panels shall be equipped with red, white, and green indicating lights. Indicating lights shall be high intensity push to test LEDs.

White lights shall indicate breaker trip and shall be wired in series with a breaker auxiliary normally closed contact and control switch slip contacts, so the light will not be energized when the breaker is operated by the control switch.

Each electrically operated breaker shall be provided with a two-pole control power disconnecting and protective device in the closing circuit and another in the tripping circuit. The disconnecting and protective device shall be either a molded-case circuit breaker or an enclosed fuse pullout.

Additional control devices shall consist of auxiliary relays and switches, control wiring and operating mechanism required for the particular breaker, an operation counter, a manually operated trip bar or lever, and provisions for manual closing.

2.2.14 Relays. The manufacturer shall furnish and install protective relays in the metal-clad switchgear in the quantities, types, and ratings indicated on the drawings and specified herein.

Switchgear protective relays shall be of the draw out type in a semiflush mounting case, with test switches and devices incorporated in the relay unit. Relays shall have hand reset indicators. Exposed metal surfaces of relays shall have a dull black finish. Relays shall be wired so that the tripping current of the circuit breaker trip coil will be interrupted by means other than relay contacts.

Relays shall have low burden, solid-state, microprocessor based circuitry and shall meet or exceed ANSI/IEEE standards. All settings shall be stored in non-volatile memory. Relays shall be manufactured by ABB Power T&D Company, Basler Electric, Cutler-Hammer, GE Power Management, Siemens Energy and Automation or approved equal.

2.2.15 Solid State Metering and Protection Unit. Microprocessor based metering and protection units shall be capable of monitoring and displaying values of phase amperes, phase voltage, watts, vars, power factor, frequency, watt-hours, and watt demand shall be provided when required. The protection functions shall include voltage phase loss, current phase loss, phase voltage unbalance, phase voltage reversal, overvoltage, undervoltage, and time delay for overvoltage, undervoltage, and phase unbalance. When required, the unit shall be capable of digital communication using a RS 232 or RS 485 twisted pair circuit. When required, the unit shall have four isolated 4-20 ma selectable outputs.

2.2.16 Overcurrent Relays. Microprocessor based multiphase and ground, instantaneous and time overcurrent relay (devices 50/51 and 50N/51N) shall have programmable trip parameters (time curve, time dial, timed pickup and instantaneous) accessible from the front of the unit. Push buttons and a digital display shall be provided for manual programming. The relay shall have eight groups of time overcurrent curves selectable from the relay memory. Fault records for at least four faults shall be stored in memory for use in trouble-shooting and system analysis. Timed overcurrent pickup range for the relay shall be 25 to 250 percent of CT secondary amperes adjustable in steps of 1 percent. Instantaneous current pickup range shall be 1 to 18 times phase pickup adjustable in steps of 0.1. Time dial range shall have at least 32 selections for each curve.

A lockout relay (device 86) shall be wired to trip the bus tie and the associated incoming feeder breakers.

2.2.17 Bus Differential Relays. When required, microprocessor based differential relays (device 87) shall provide a zone of protection which shall overlap the tie breaker and include all breakers normally served by the associated incoming feeder breaker.

A lockout relay (device 86), shall be wired to trip all breakers associated with the zone.

2.2.18 Power Company Metering Sections. Metering sections shall consist of a sheet steel enclosed stationary cubicle of sufficient width to provide the specified spacing and clearance required by the power company. The section shall include the following equipment:

> Set of draw out carriage and mounting provisions for metering potential transformers as required, with primary windings connected line-to-line, and associated primary fuses. The potential transformers and fuses will be provided by the power company.
>
> Set of mounting provisions for metering current transformers as required.

The current transformers will be provided by the power company.

Set of primary leads for potential transformers. These leads shall be connected to the main bus and shall be coiled during shipment.

Set of secondary leads for the potential transformers. These leads shall be connected to a meter test block and shall be coiled during shipment.

Set of secondary leads for current transformers. These leads shall be connected to a meter test block.

Blank inner panel, not less than 30 inches (760 mm) wide and 30 inches (760 mm) high, with at least 15 inches (380 mm) clearance between the face of the panel and the front door, for field mounting of power company metering equipment.

Hinged door on the draw out side of the switchgear, with provisions for a power company padlock and a nameplate.

It is the intent of this specification that the Power Company will furnish current transformers, potential transformers, potential transformer fuses, meter sockets, and sealing rings. The Power Company will also provide mounting dimensions for the instrument transformers and fuses. If the Power Company wishes to ship the instrument transformers to the manufacturer, the transformers and fuses shall be mounted in the switchgear during fabrication and assembly. Depending upon the manufacturer, the Power Company may elect to place an order with the manufacturer for the instrument transformers and fuses. In this case, the manufacturer shall furnish the instrument transformers completely assembled in the switchgear at no additional cost.

The name of the Power Company and the contact person shall be obtained from Owner.

2.2.19 Auxiliary Power Section. Auxiliary power sections shall consist of a sheet steel enclosed stationary cubicle, which houses the following:

Draw out auxiliary transformer, 15 kVA or as required, 120/240 volts, complete with primary current-limiting fuses.

Breaker panel with thermal-magnetic, 10,000 ampere interrupting breakers, including a two-pole, 70 ampere or as required, main breaker. The panel shall be wired to the 120/240 volt transformer in this section and to all switchgear loads specified or indicated on the drawings. Six spare 15 ampere breakers shall be included.

When required, the switchgear lineup shall be equipped with an uninterruptible power supply (UPS) mounted in an accessory compartment. The UPS shall provide backup power to the Auxiliary Power Section circuit breaker panel and shall be equipped with 25 percent spare capacity. The UPS shall be off-line type with a minimum backup time of 10 minutes and a minimum 600 VA rating.

2.2.20 Potential Transformers Sections. Potential transformer sections shall consist of a sheet steel enclosed stationary cubicle, which houses the following:

Set of draw out potential transformers as required by the drawings.

Hinged door, on the draw out side of the switchgear, serving as an instrument and control panel containing a voltmeter to indicate line-to-line voltage and a voltmeter transfer switch when required.

2.2.21 Ground-Test Device. When indicated, a grounding, phasing, and testing device shall be furnished. The device shall be designed so that it can be inserted in the switchgear units in place of and in the same manner as the circuit breaker removable elements, to permit grounding either the bus or the feeder, or to make connections to either the bus or the feeder for testing purposes. The device shall include a solenoid-operated circuit closing device arranged with a gang-operated, three-pole selector disconnect switch to effectively ground either the bus or the feeder when the device is inserted in the unit and closed. The device shall be electrically closed by a suitable remote control switch station connected to the device by a 35 foot (11 m) flexible cable to permit the operator to stand well clear of the equipment. The device shall have momentary and 4-second current-carrying capacities at least equal to those of the circuit breakers. The device shall connect solidly to the ground bus in the unit when in the operating position. No provisions for automatic tripping of the device shall be included. The device shall be provided with suitable windows or a transparent enclosure and barriers to permit visual observation of the positions of all selector switch blades.

External connections for testing shall be made by 15 kV insulated plug connectors for insertion into deep ports or wells on the face of the device. The ports shall be provided with closing shutters. Locking and interlocking features shall be provided to prevent improper or unsafe operation of the equipment.

2.2.22 Wiring. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and at least 25 percent spare terminal points. Switchgear secondary wire shall be 14 AWG (2.5 mm^2), Type SIS, rated 600 volts, 195°F (90°C), and furnished with wire markers at each termination. Wires shall terminate on terminal blocks, with marker strips numbered to agree with detailed connection diagrams.

Compression type lugs, of the size indicated on the drawings, shall be furnished for all incoming line and feeder cables. The design and arrangement of each section shall provide sufficient space for terminating power cables with IEEE Class 1 stress cones. The design shall take into account space for minimum bending radii of the cables to be terminated.

2.2.23 Switchgear Arrangement. The assembly shall consist of sections arranged as indicated on the drawings and as specified herein.

2.2.24 Incoming Line Sections. When incoming line sections are required, each section shall consist of a basic incoming line unit, which houses the equipment and devices as indicated on the Contract Documents; installed and completely wired.

2.2.25 Bus Tie Breaker Sections. When bus tie sections are required, each section shall consist of a bus sectionalizing unit, which houses the equipment and devices as indicated on the Contract Documents installed and completely wired.

2.2.26 Feeder Breaker Sections. When feeder breaker sections are required, each section shall consist of a basic feeder unit, which houses the equipment and devices as indicated on the Contract Documents installed and completely wired.

2.2.27 Power Company Metering Sections. When power company metering sections are required, each section shall consist of a stationary cubicle which houses the transformers and devices as indicated on the Contract Documents installed and completely wired.

2.2.28 Auxiliary Power Sections. When auxiliary power sections are required, each section shall consist of a sheet steel enclosed stationary cubicle, which houses the transformers and devices as indicated on the Contract Documents installed and completely wired.

2.2.29 Potential Transformers Sections. When potential transformer sections are required, each section shall consist of a sheet steel enclosed stationary cubicle, which houses the transformers and devices as indicated on the Contract Documents installed and completely wired.

2.3 ACCESSORIES.

2.3.01 Special Tools and Accessories. Special tools, instruments, and accessories required for proper maintenance; and special devices for lifting or handling shall be furnished. The following accessories shall be supplied with the metal-clad switchgear.

Set of special wrenches or tools required for installation, operation, or maintenance of the equipment.

Test cabinet with test jumper for testing breakers out of the housing, for mounting on the wall, and wired for a power source separate from the switchgear control bus.

Breaker lifting device and transfer truck for moving the circuit breaker into and out of the breaker housing.

Set of extension rails.

Maintenance closing lever for closing the circuit breakers.

Manual operating lever for moving the breaker element into and out of the operating position.

Set of test plugs suitable for testing the relays.

2.4 SHOP PAINTING. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop coated with the manufacturer's standard coating. Finish color shall be ANSI 61 for indoor equipment and ANSI 61 or 70 for outdoor equipment. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup painting of damaged coatings.

The underside of equipment installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is considered to be the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting.

2.5 SHOP TESTS. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and other standard tests for the particular class of equipment, as defined by industry standards.

PART 3 - EXECUTION

3.1 INSTALLATION. Installation will be in accordance with the drawings, specifications, and manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.2.02 Field Installation Supervision. The equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the contract price for the number of days and round trips to the site as required.

Manufacturers' installation supervisor shall observe, instruct, guide, and direct Contractor's erection or installation procedures as required. The equipment manufacturer will be provided with written notification 10 days prior to the need for such services.

End of Section

SECTION 16360

METAL-ENCLOSED LOAD INTERRUPTER SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE. This section covers an expandable line-up of metal-enclosed load interrupter switchgear that shall be furnished and installed as specified herein and as indicated on the drawings. The assembly shall consist of dead-front, completely metal-enclosed vertical sections containing load interrupter switches and fuses of the numbers, ratings, and types indicated on the drawings.

Switchgear shall meet the design conditions and features as indicated.

Switchgear shall be designated and shall be located as indicated on the drawings.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer. At least six feet (2 m) of clear access space shall be provided in front of the switchgear.

1.2.03 Workmanship and Materials. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard size and thickness so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
AWG	American Wire Gage
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.2.05 Governing Standards. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the latest applicable standards of ANSI, NEMA, and IEEE, including, but not limited to, IEEE C37.20.3 & 4, and NEMA SG 6.

1.2.06 Nameplates. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors and rear cover plates. Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be ¾ inch (9mm) high for section identity and 1/8 inch (3 mm) high for other information.

Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1.2.07 System Characteristics. This equipment will be connected to power system with characteristics as indicated on the drawings.

1.2.08 Rating. The metal-enclosed load interrupter switchgear assembly shall have minimum ratings as indicated.

1.2.09 Load Interrupter Switch Rating. The load interrupter switches shall be quick-make, quick-break, three pole, and gang operated. Switches shall meet the requirements of IEEE C37.20.4 and shall have minimum ratings as indicated.

1.3 SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the switchgear, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data for switchgear shall include, but shall not be limited to the following:

Elevation plan, weights, and bill of material.

Single-line, control schematic, wiring connection, and wiring interconnection diagrams.

Fuse time-current characteristic curves.

When a power company metering compartment is specified, drawings and details pertaining to each utility metering section shall be subject to the approval of the electric utility company in addition to review by Engineer. For Operations and Maintenance Data and Manuals, provide the following:

Assembly, installation, alignment, adjustment, and checking instructions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered and shall meet therequirements of Master Specification Section 01160, Training and Operation & Maintenance Manuals.

1.4 SHIPPING, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.4.01 Preparation for Shipment. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked. Complete packing lists and bills of material shall be included with each shipment.

1.5 SPARE PARTS. One set of spare power fuses shall be furnished for each fused switch and five spare control fuses for each fuse type and ampere rating supplied in the line-up. Spare parts shall be suitably packaged, with labels indicating the contents of each package and shall meet all the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Spare parts shall be delivered to Owner as directed.

1.6 COORDINATION STUDY. When a coordination study of the power distribution system will be conducted in accordance with Master Specification Section 16050, Electrical General Requirements, the initial shop drawing submittal for the equipment shall include the coordination curves for each fuse provided as a part of the metal-enclosed switchgear assembly.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. The switchgear shall be manufactured by Cutler-Hammer, Siemens Energy & Automation Inc., S&C Electric Company, Square D, or approved equal.

2.2 CONSTRUCTION. The enclosure for each bay shall be designed according to all relevant design factors such as controlled access and tamper-resistance; shall be sealed against ingress of rodents, insects, and weeds; and shall include provisions to preclude the possibility of arcing faults within the enclosure.

The enclosures shall be constructed to maximize strength, minimize weight, and inhibit corrosion. The basic material shall be 11 gage (3.04 mm thick) sheet steel. Each bay containing high-voltage components shall be a complete, self-contained unit, with full side sheets securely bolted together and with steel floor plates.

Adequate bracing shall be provided for seismic forces.

The top and side edges of adjoining bays shall be equipped with gasket seals to keep out water. The roof shall be weather-sealed with suitable gaskets, and bus openings between bays shall be gasketed for additional protection against entrance of water.

Each bay shall have ventilation louvers, with an inside screen and baffle, at the top and bottom. Louvers shall be rain- and corrosion-resistant, with externally accessible glass fiber filters.

All hardware shall be either of nonferrous material or of galvanized or zinc-plated ferrous materials. Cadmium-plated ferrous parts are not acceptable.

Outdoor vertical sections shall have a sloped weatherproof roof. All openings shall be fitted with screens to keep out small animals, and with barriers against snow, sand, and blowing debris.

2.2.01 <u>Vertical Sections</u>. The following features shall be incorporated in every vertical section containing a three-pole, two-position open-closed switch:

> A high impact viewing window in the door that permits full view of the position of all three switch blades with out opening the door.
>
> The door shall be interlocked with the switch so that the switch must be opened before the door can be opened, and the door must be closed before the switch can be closed.
>
> When indicated, a grounded metal barrier in front of every switch to prevent inadvertent contact with any live part, yet allow full-view inspection of the switch blade position.
>
> Provisions for padlocking the switch in the open or closed position.
>
> Permanent "Open-Closed" switch position indicators.

When indicated, at least one 250 watt, 120 volt space heater shall be provided in each vertical section to prevent condensation. Space heaters shall be controlled by a thermostat that is factory-set to maintain the enclosure above the dewpoint for anticipated environmental conditions. Power for the space heaters shall be furnished as indicated.

2.2.02 <u>Buses</u>. All phase bus conductors shall be tin-plated copper and shall be mounted on NEMA insulators rated for the design voltage of the switchgear. A continuous tin-plated copper ground bus shall be provided throughout the multi-bay lineup.

2.2.03 <u>Wiring</u>. One NEMA terminal pad per phase shall be provided along with compression type cable terminal lugs for a maximum of two conductors per phase. The cable sizes are indicated on the drawings. Sufficient vertical space shall be allowed for electrical stress relief termination devices.

Small wiring, fuse blocks, and terminal blocks within the vertical section shall be furnished as indicated on the drawings. Each control wire shall be labeled with wire markers. Terminal blocks shall be provided for customer connections to other apparatus. Current transformer secondary windings shall be connected to shorting-type terminal blocks. All terminal blocks and connection points shall be readily accessible.

2.2.04 Key Interlocks. Key interlocks shall be supplied as required and as indicated on the drawings to prevent switch operation unless the associated device is in the correct position.

2.2.05 Lightning Arresters. When indicated, intermediate class metal oxide lightning arresters, rated as required, shall be provided. The arresters shall be connected at the incoming terminations, and securely grounded to the metal structure.

2.2.06 Load Interrupter Switches. The load interrupter switches shall have a stored energy type mechanism that utilizes a heavy-duty coil spring to provide opening and closing action. The speed of opening and closing the switch shall be independent of operator control, and it shall be impossible to "tease" the switch into any intermediate position. Automatic operation shall be accomplished by an electric motor or a linear actuator that charges the spring of a manually operated switch.

The interrupter switches shall have silver or silver alloy main contacts and auxiliary contacts, if required, to provide maximum endurance for fault closure and load interrupting duty. Insulating barriers, as needed, shall be provided between each phase and between the outer phases and the enclosure. The switches shall include a maintenance provision for slow closing to check switch blade engagement and for slow opening to check the operation of the arc interrupting contacts.

2.2.07 Motor Operators. Switches shall be supplied with motor operators when required, and as indicated on the drawings. All motor operated switches shall consist of a standard manually operated switch in combination with an electric motor or linear actuator type drive that charges the spring. The motor operator and the associated low-voltage wiring shall be mounted in a low-voltage compartment or separated from the high voltage by a barrier.

Motor operator voltage shall be 120 volts ac or 125 volts dc as indicated.

2.2.08 Fuses. All fuses shall be disconnect style. Fuses in feeder bays shall include provisions for grounding on the load side and on the enclosure ground bus. Each fuse shall be equipped with a blown fuse indicator that provides visible evidence of fuse operation while installed in the fuse mounting. Fusible elements shall be nonaging and nondamageable so that it is unnecessary to replace unblown companion fuses following a fuse operation. Fusible elements shall be protected from damage by current surges.

All arcing accompanying power fuse operation shall be contained within the fuse and any arc products and gases resulting from fuse operation shall be vented through exhaust control devices.

2.2.09 Power Company Metering Sections. When a power company metering section is required, it shall contain provisions for current transformers and voltage transformers, as required, and shall conform to all applicable power company standards, including arrangement and size. The metering sections shall also conform to the general electrical and construction requirements for the switchgear assembly specified above.

It is the intent of this specification that the Power Company will furnish current transformers, potential transformers, potential transformer fuses, meter sockets, and sealing rings. The Power Company will also provide mounting dimensions for the instrument transformers and fuses. If the Power Company wishes to ship the instrument transformers to the manufacturer, the transformers and fuses shall be mounted in the switchgear during fabrication and assembly. Depending upon the manufacturer, the Power Company may elect to place an order with the manufacturer for the instrument transformers and fuses. In this case, the manufacturer shall furnish the instrument transformers completely assembled in the switchgear at no additional cost.

2.2.10 Customer Metering. When indicated on the drawings, the switchgear section(s) shall be provided with microprocessor-based, digital power meters. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Current transformers shall be wired to shorting-type terminal blocks. Potential transformers shall include primary and secondary fuses and a disconnecting means. Currents, voltages, active power, reactive power, power factor, watt-hours, frequency, and demand values shall be available for display. Total harmonic distortion waveforms shall also be available. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of RS 485 serial communication for remote monitoring. The digital power meters shall have built-in face display and shall be Cutler-Hammer "IQ Analyzer", Multilin PQM, Square D PowerLogic Model 2350, Basler "Energy Transducer", or approved equal.

Sufficient lengths of communication cable shall be provided for connection of metering units within the switchgear and as indicated on the drawings.

The metering package shall be compatible with the metering system software and metering system network as indicated in the Contract Documents. Contractor shall furnish and install applications software for origination and display of all metering data and microprocessor-based trip-unit data as indicated in the Contract Documents.

The unit shall have two isolated 4-20 ma selectable outputs.

2.2.11 Shop Painting. All iron and steel surfaces, except stainless steel and machined surfaces, shall be shop painted with the manufacturer's standard coating to a minimum thickness of 2 mils (50 mm). Finish color shall be ANSI 61 for both indoor and outdoor equipment. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

The underside of equipment installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during and after installation. The underside is defined as the surfaces in contact with the concrete mounting pad and other surfaces not readily accessible for field painting.

2.2.12 Shop Tests. The manufacturer shall supply test results to confirm that the design of the switchgear assembly has been tested for conformance with applicable ANSI and NEMA standards, and for UL listing when required. The tests shall verify not only the performance of the switch or integrated switch and fuse, but also the adequacy of the enclosure venting, rigidity, and bus bracing. In addition, the switchgear assembly shall be factory tested in accordance with IEEE C37.20.3, C37.57, and C37.58.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment shall be installed in accordance with the drawings, specifications, and the equipment manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

End of Section

SECTION 16395

MEDIUM-VOLTAGE MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE. This section covers medium-voltage motor control equipment that shall be furnished and installed as specified herein, as indicated on the drawings. Medium-voltage motor control equipment shall meet the design conditions and features as required.

Medium-voltage motor control equipment shall be designated and shall be located as indicated on the drawings.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1.2.03 Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

ANSI	American National Standards Institute
AWG	American Wire Gage
ICS	Industrial Control and Systems
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

1.2.05 Governing Standards. All equipment furnished under this section shall be designed, constructed, and tested according to UL 347 and NEMA ICS 3-1993.

Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before testing, Contractor shall submit a copy of the testing procedure that will be used in evaluating the equipment.

1.2.06 Nameplates. Nameplates with unit description and designation of each control or indicating device shall be provided on hinged doors. Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/4 inch (9mm) high for section identity and 1/8 inch (3 mm) high for other information.

Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1.2.07 System Characteristics. The medium voltage motor control equipment will be connected to an electric system with characteristics as indicated on the drawings.

1.3 SUBMITTALS.

1.3.01 Drawings and Data. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor controllers, shall be submitted in accordance with Master Specification Section 01080, Project

Submittals. The drawings and data for the motor controller lineup shall include, but shall not be limited to, the following:

Elevations, plan, and weight.

Unit wiring diagrams showing devices, connections, and terminal designations.

Interconnection diagrams.

Control schematic diagrams.

Fuse time-current characteristic curves.

Motor protective relay time-current characteristic curves.

1.3.02 Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals and shall include the following:

Assembly, installation, alignment, adjustment, and checking instructions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 SHIPPING, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.4.01 Preparation for Shipment. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Grease and lubricating oil shall be applied to all bearings and similar items.

Each item of equipment shall be tagged or marked as identified on the drawings or Equipment Schedule Sheet. Complete packing lists and bills of material shall be included with each shipment.

1.5 SPECIAL TOOLS AND SPARE PARTS. All special tools and other devices normally furnished or required for installation, care, and maintenance of the controller equipment shall be furnished. Spare parts shall be provided as indicated on the Contract Documents and shall meet all the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

1.6 COORDINATION STUDY. When a coordination study of the power distribution system will be conducted in accordance with Master Specification Section 16050, Electrical General Requirements, the equipment manufacturer shall provide the following information to Engineer with the initial equipment shop drawings:

> Protective relay coordination curves and operation manuals for each relay provided as a part of the medium-voltage motor control assembly.
>
> Protective fuse curves for each current-limiting fuse provided as a part of the medium-voltage motor control assembly.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS. The interrupting rating of the line up assembly and the motor controllers shall be 350 MVA symmetrical at 4,000 volts, or 200 MVA symmetrical at 2,300 volts, as indicated.

The power bus shall be braced for 50 kA symmetrical or greater.

2.2 ACCEPTABLE MANUFACTURERS. The equipment shall be manufactured by Cutler-Hammer, General Electric, Siemens Energy & Automation, Square Dor approved equal.

2.3 MAIN DISCONNECT, BUS TIE, AND FEEDER UNITS. When shown on the drawings, each unit shall include a gang operated load break switch and current limiting type fuses. Isolating switch and fuse units, instrument transformers, buses, and outgoing cable connections shall be provided in separate compartments formed by grounded steel barriers. Key interlocks shall be provided where indicated on the drawings or as required.

2.3.01 Load Break Switches. Gang-operated load break switches shall be stationary, manually operated, three-pole, single-throw disconnecting type, with integral interrupter and stored-energy mechanism. Each switch shall have an external operating handle, with provisions for padlocking the switch in both the "On" and "Off" positions. Mechanical interlocks shall be provided to prevent the switch from being operated when the door is open and the door from being opened when the switch is closed.

Load break switch ratings shall be 5 or 15 kV, 60 or 95 kV BIL, and 600 or 1200 amperes, as indicated.

A viewing window shall be provided at each switch to display the condition and position of the switch blades and the blown-fuse indicator.

2.3.02 Fuses. Current-limiting fuses shall ensure positive interruption of faults to limit the magnitude of short-circuit currents and electromechanical stresses to values within the allowable design of the component apparatus of the control assembly.

A positive action indicator shall be provided to identify fuses blown during operation. Fuses for protection of potential transformers, control power transformers, power transformers, and feeder circuits shall be Cutler-Hammer "Type CLE", General Electric "Type EJ-1", Gould Shawmut "Type CS-3", or approved equal.

2.3.03 Metering. When indicated, the main disconnect section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Currents, voltages, active power, reactive power, power factor, watt-hours, frequency, and demand values shall be available for display. Total harmonic distortion waveforms shall also be available. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of RS 485 serial communication for remote monitoring. The digital power meters shall have built-in face display and shall be Cutler-Hammer "IQ Analyzer", Multilin PQM, Square D PowerLogic Model 2350, Basler "Energy Transducer", or approved equal.

Sufficient lengths of communication cable shall be provided for connection of metering units within the motor control lineup and as indicated on the drawings.

The metering package shall be compatible with the metering system software and metering system network as indicated in the Contract Documents. Contractor shall furnish and install applications software for origination and display of all metering unit data and microprocessor-based trip-unit data as indicated in the Contract Documents.

The unit shall have two isolated 4-20 ma selectable outputs.

2.4 MOTOR AND FEEDER CONTROLLER UNITS. Each controller unit shall consist of an externally operable isolation switch and a magnetically operated vacuum contactor with current limiting fuses as indicated on the drawings.

2.4.01 Isolation Switch. Each controller shall be isolated by a quick-make quick-break isolation switch with an externally mounted operating handle. Mechanical interlocks shall be provided to prevent operation of the isolation switch under load, opening of the high-voltage compartment door before the controller is isolated, and closing the contactor while the door is open.

2.4.02 Fuses. Fuses for motor controller duty shall be Cutler-Hammer "Type CLS", General Electric "Type EJ-2", Gould Shawmut "Type A480R", Siemens "Type FM", or approved equal.

2.4.03 Controllers. Controllers shall be drawout type, for full voltage or reduced voltage autotransformer type starting as indicated. Controllers shall be provided with current-limiting fuses to meet the interrupting rating indicated, and shall be suitable to operate induction or synchronous motors as required. Controllers shall use magnetically operated vacuum contactors rated 360 or 720 amperes and having an interrupting capacity of 50 mVA, 3 phase symmetrical.

2.5 PROTECTIVE RELAYS. Relays shall be provided as indicated on the drawings and as specified herein.

2.5.01 Motor Protection Relay-Thermistor Protection. When indicated, the electronic motor protection relay shall protect the motor against overload (51), single phase/unbalance (46), winding overtemperature (49), phase short circuit (50) and ground fault (50G/50N). Overtemperature sensing shall be via a 100 to 30,000 ohm thermistor input. Programmable setpoints and fault diagnosis data shall be available from a front panel 2-line digital display. Four relay outputs shall be provided, including trip, alarm, service (internal fault), and a programmable auxiliary contract.

The relay shall include a 2-wire RS485 communication port, suitable for ModBus RTU communication protocol. The relay shall be Multilin "Model 239", Basler "MPS100", or approved equal.

2.5.02 Motor Protection Relay-RTD Protection. When indicated, the electronic motor protection relay shall protect the motor against overload (51), single phase/unbalance (46), overtemperature (49), short circuit (50), undercurrent (37), starts per hour (66), power factor (55), and ground fault (50G/51G). Overtemperature sensing shall be via RTD inputs from the motor windings and motor bearings as indicated on the drawings. The relay shall accept up to 10 RTD inputs for overtemperature sensing. Programmable setpoints and fault diagnosis data shall be available from a front panel 2-line digital display. Four relay outputs shall be provided, including trip, alarm, service (internal fault), and a programmable auxiliary contract.

The relay shall include a 2-wire RS485 communication port, suitable for ModBus RTU communication protocol. The relay shall be Multilin "Model 369", Basler "MPS200", or approved equal.

2.6 CONSTRUCTION. Each control lineup shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the drawings or specified herein.

2.6.01 Sills and Anchors. Contractor shall furnish and install steel channels, floor sills, and anchor bolts as required by the equipment manufacturer for proper installation.

2.6.02 Enclosures. When indicated, enclosures shall be NEMA Type 1 with gasketed doors for indoor locations, NEMA Type 3R walk-in for outdoor locations, or NEMA Type 3R non-walk-in for outdoor locations.

2.6.03 Vertical Sections. When indicated, the equipment furnished shall be of two-high type construction in which two single full-voltage motor controllers require a full-height section of the equipment, or of one-high type construction in which a single full-voltage motor controller requires a full-height section of the equipment.

Equipment shall consist of a lineup of freestanding, metal-enclosed cubicles forming an integrally built group of medium-voltage control. All connections and servicing shall require access from the front only.

The individual sections shall be divided into high voltage and low voltage compartments, to assure isolation of equipment for safety of personnel during servicing and maintenance or cable pulling, while adjacent sections of the group remain energized.

2.6.04 Wiring Labels. All internal wires shall be labeled at each termination. Terminals shall also have labels giving the terminal block and terminal number.

2.6.05 Busing. All buses shall be tin-plated copper and shall be covered with molded insulating material or shall be taped. The main horizontal bus shall be located in an isolated bus compartment within or at the top of the enclosure and shall be rated 600, 1000, 1200, or 2000 amperes as indicated.

A tin-plated copper ground bus rated at least 500 amperes shall be furnished through the lineup. A clamp type connector shall be provided on each end of the ground bus for external connection of a 500 kcmil (240 mm^2) stranded copper grounding cable to the grounding system. A clamp type connector shall also be provided in each controller section for connection of stranded copper grounding cable run with incoming and outgoing phase wires, as indicated on the drawings.

2.6.06 Current Transformers. Current transformers shall be selected so that full load secondary currents will be approximately 2.5 to 4.0 amperes to provide for proper operation of out-of-step protective relays on synchronous motors, and shall be coordinated with indicating meters so they read one-half to three-quarters scale at full load. Conventional wound type current transformers having higher burden-capacity, up to 200 volt-amperes within general industry accuracy requirements, shall be furnished where necessary for certain devices such as current type phase reversal relays. "Ring" type current transformers, with burden-capacity as low as 50 volt-amperes, may be used where such capacity is sufficient for the particular application.

2.6.07 Potential Transformers. Potential transformers shall have a primary voltage rating that is not exceeded by more than 10 percent under normal conditions, yet under emergency conditions the transformers shall function at temporary system over voltage of 1.25 times primary voltage rating. The transformer insulation-class voltage shall in all cases exceed the system line-to-line voltage. Thermal ratings shall be such that, at rated voltage, the burden imposed does not cause the allowable temperature rise to be exceeded. Transformers shall meet the required accuracy limits in accordance with the ANSI accuracy classification system. Potential transformers shall be General Electric "Type JVM-3" or "Type JVM-4", Siemens "Type DP" or "Type PT3-45", Cutler- Hammer "Type PT-45", or approved equal. Current-limiting primary fuses shall be provided.

2.6.08 Control Power Transformers. Individual control power transformers shall be provided with each contactor and each motor starter. The transformer primary windings shall be fused and the secondary windings shall have one lead fused and the other grounded. Control power transformers, which serve external device loads, shall have extra capacity for motor space heaters and other associated equipment.

2.6.09 Control Test Circuit. Test control power interlocking provisions shall allow testing of contactor or starter control operations from an external source of 120 volt control power with the high voltage disconnected and isolated.

2.6.10 Cable Connectors. Crimp type terminal connectors for incoming and outgoing power cables shall be provided in each section. Connectors shall match the size of cables and the number of cables per phase as indicated on the drawings. Connectors to the ground bus shall be provided in each section for connecting the grounding cable in each power circuit.

2.6.11 Stress Cones. The design and arrangement of each section shall provide sufficient space for terminating power cables with IEEE Class 1 stress cones. The design shall provide adequate space for minimum bending radii of the cables to be terminated.

2.6.12 Relays and Timers. Auxiliary relays and timers shall have 120 V ac, 60 Hz coils for continuous duty in 105 F (40 C) ambient, and 10 ampere, 120 V ac contacts. Auxiliary relays shall be NEMA rated.

2.6.13 Control Switches and Pilot Lights. Control switches and pilot lights shall be heavy-duty, oiltight construction. Pilot lights shall be transformer type with high intensity push to test LED lamps.

2.6.146 Auxiliary Contacts. Auxiliary contacts for interlocking and control shall be furnished as indicated on the drawings. In addition, one spare NO isolated contact and one spare NC isolated contact shall be provided on each controller.

2.6.15 Wiring. All external connections to the equipment will enter at the bottom or the top as indicated. As much space as possible shall be provided for conduits in unit floors and tops. All spare contacts shall be wired to terminals for external connections. In addition to spare contact terminals and spare terminals, terminals marked to match the manufacturer's drawing shall be provided for all connections wired through the controllers.

2.6.16 Space Heaters. Space heaters shall be furnished in each section or unit of motor control groups provided with NEMA Type 3R enclosures. The heaters shall be thermally insulated and shall be located to prevent damage or discoloration to painted surfaces. Heaters shall be located where they do not interfere with cable entrances. The heaters shall be controlled by an adjustable thermostat set to open when the temperature rises to 90°F (32°C) and to close when the temperature falls below 85°F (29°C), and shall have capacity to maintain the interior temperature above dew point of the section. Heaters shall be rated 120 volts ac.

When indicated, space heater wiring, with branch circuit protection, shall be factory installed, with terminals provided for connection of an external power supply.

When indicated, power to space heaters shall be supplied from the unit control power transformer. All wiring and branch circuit protection shall be factory installed.

2.7 SHOP PAINTING. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop coated with the manufacturer's standard coating. Finish color shall be ANSI 61 for indoor equipment and ANSI 61 or 70 for outdoor equipment. Field painting, other than touch up painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touch up painting of damaged coatings.

The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside shall be considered to be the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting.

2.8 SHOP TESTS. The complete control lineup shall be tested at the factory. All circuits, including power and control circuits, shall be tested in accordance with NEMA ICS 3.

2.9 ACCESSORIES. Special tools, instruments, and accessories needed for proper maintenance, and special devices for lifting or handling, shall be furnished.

PART 3 - EXECUTION

3.1 INSTALLATION. Equipment shall be installed in accordance with the drawings, specifications, and the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Supervision. When indicated, the equipment manufacturer shall furnish a qualified field installation supervisor during the equipment installation. Such services shall be included in the contract price.

Manufacturers' installation supervisor shall observe, instruct, guide, and direct Contractor's erection or installation procedures as required. The equipment manufacturer will be provided with written notification 10 days prior to the need for such services.

3.2.02 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, set all relays in accordance with the settings designated in the coordination study, and approve the equipment installation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools. The representative shall be present when the equipment is placed in operation. Such services shall be included in the contract price.

All over current protective devices shall be adjusted as required by Engineer. Current limiting fuse selection shall be checked and over current relays shall be adjusted according to NEC requirements and the relay coordination study. All controls shall be tested for conformance with schematics or as required by Engineer.

The manufacturer's representative shall furnish a written report certifying that equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting conduit or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

End of Section

SECTION 16425

SWITCHBOARDS

PART 1 - GENERAL

1.1 SCOPE. This section covers switchboard equipment, which shall be furnished and installed as specified herein and as indicated on the drawings. Switchboards shall meet the following requirements, and the design conditions and features as required.

Switchboards shall be designated and shall be located as indicated on the drawing.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers, and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1.2.03 Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

AISI	American Iron and Steel Institute

ANSI	American National Standards Institute
AWG	American Wire Gage
ICS	Industrial Control and Systems
IEEE	Institute of Electrical and Electronics Engineers
MIL	Method of Insertion Loss Measurement
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Assocation
NRTL	Nationally Recognized Testing Laboratory
UL	Underwriters' Laboratories

1.2.05 Governing Standards. All equipment furnished under this section shall be designed, constructed, and tested in accordance with all the applicable standards of ANSI, NEMA, and UL, including, but not limited to, NEMA PB 2 and UL 891 (switchboards); NEMA AB1 and UL 489 (molded-case circuit breakers); ICS-6 (enclosures); and NEMA PD 2.2 (Ground Fault Protection).

Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be conducted at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

1.2.06 Nameplates. Each switchboard section shall have a nameplate permanently affixed to it, listing the following information:

Name of manufacturer.

System voltage.

Main bus rating.

Type.

Manufacturer's shop order number and date.

In addition, each circuit breaker and instrument on the front of the switchboard shall have a suitable nameplate. Each incoming line section shall be furnished with a nameplate to indicate the power source or substation from which it is fed. The nameplates for the distribution circuit breakers shall indicate the equipment fed through the breaker. Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/4 inch (19mm) high for section and circuit breaker identity and 1/8 inch (3 mm) high for other information.

Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

1.2.07 System Characteristics. The equipment will be connected to a system as indicated on the drawings.

1.3 SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the switchboard, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data for switchboard shall include, but shall not be limited to, the following:

Elevation, plan, conduit entrance locations, and weight.

Circuit breaker time-current characteristic curves.

Nameplate legends and equipment schedule.

Single-line and control wiring interconnection diagrams.

Metering section details.

Shop test report.

Installation report.

When transient voltage surge suppressors are required, submittals shall include manufacturer's catalog and specification data, including device dimensions, weight, material composition, and connection diagrams. Documentation shall be provided showing the file number of compliance with UL 1449 listing requirements and results of independent, third party NRTL certification of listed surge ratings. The test results submitted shall include UL file number, date of report, product covered, electrical ratings, voltages, phases, modes of protection, nomenclatures, and UL 1449 ratings with and without disconnect device.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Assembly, installation, alignment, adjustment, and checking instructions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 SPARE PARTS. Spare parts shall be provided as indicated on the Contract Documents.

Spare parts shall be suitably packaged with labels indicating the contents of each package and shall meet all the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools. Spare parts shall be delivered to Owner as directed.

1.6 COORDINATION STUDY. When a coordination study of the power distribution system will be conducted as specified in Master Specification Section 16050, Electrical General Requirements, the equipment manufacturer shall provide the following information to Engineer with the initial equipment drawing submittal:

Protective relay coordination curves for each solid-state trip device.

Time current curves shall be provided for circuit breakers as required.

Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

1.7 SHIPPING, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. The switchboard shall be manufactured by Cutler-Hammer, General Electric, Siemens Energy & Automation, Square D,or approved equal.

2.2 INCOMING LINE SECTIONS. Incoming line sections shall be provided as shown on the one-line diagram and when required shall have all necessary components for a cable pull box, a busway entry compartment, a power utility metering compartment, an Owner metering compartment, or a main breaker.

2.2.01 Cable Pull Box. When indicated, each bussed pull section shall have compression type terminals for the number and size of copper conductors indicated on the drawings. When indicated, the cable pull box shall include provisions for a power utility seal.

2.2.02 Busway Entry Compartment. When the switchboard is fed by a busway, the switchboard manufacturer shall be responsible for coordination, proper phasing and internal bussing to the incoming busway. All hardware, splice plates, flexible connectors, and insulating material for connection to the switchboard shall be furnished.

2.2.03 Power Utility Metering Compartment. This compartment shall meet the requirements of the local utility and shall be provided with a sealable hinged door. Busses shall include provisions for mounting utility company current transformers and potential transformers or bus taps.

2.2.04 Owner Metering Compartment. When indicated, the incoming line section(s) shall be provided with a microprocessor-based, digital power meter for Owner metering. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Currents, voltages, active power, reactive power, power factor, watt-hours, frequency, and demand values shall be available for display. Total harmonic distortion waveforms shall also be available. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kvar limit, voltage sequence reversal, underfrequency, and overcurrent. The metering package shall be capable of RS 485 serial communication for remote monitoring. The digital power meters shall have built-in face display and shall be Cutler-Hammer "IQ Analyzer", Multilin "PQM", Square D "PowerLogic Model 2350", Allen-Bradley "Power Monitor II", Basler "Energy Transducer" or approved equal.

Sufficient lengths of communication cable shall be provided for connection of metering units within the switchboard and as indicated on the drawings.

When indicated, the metering package shall be compatible with the metering system software and metering system network as indicated in the Contract Documents. Contractor shall furnish and install applications software for origination and display of all metering unit data and microprocessor-based trip-unit data as indicated in the Contract Documents.

The unit shall have two isolated 4-20 ma selectable outputs.

2.2.05 Main Breaker. When indicated, each incoming line section shall include a molded case, fixed mounted insulated case, or drawout insulated case power circuit breaker with a current rating as indicated on the drawings. Internal control power transformers shall be provided to furnish control power for insulated case power circuit breakers.

Compression type terminals shall be provided for terminating the number and size of copper conductors indicated on the drawings.

When indicated, the incoming line circuit breakers shall be furnished with a captive key interlock to prevent both incoming circuit breakers from being closed at the same time.

2.3 TIE BREAKER SECTION. Each tie breaker section shall include a molded case, fixed mounted insulated case, or drawout insulated case power circuit breaker with a current rating as indicated on the drawings. Internal control power transformers shall be provided to furnish control power for insulated case power circuit breakers.

2.4 DISTRIBUTION SECTION. The distribution section shall be provided to house branch circuit breakers as indicated on the drawings. Circuit breakers shall be molded case (individually mounted or panel mounted as indicated), fixed mounted insulated case, or drawout insulated case as indicated. Circuit breakers shall be removable from the front without disturbing adjacent units. The switchboard shall contain space for future units as indicated on the drawings.

2.5 TRANSIENT VOLTAGE SURGE SUPPRESSION. When indicated, transient voltage surge suppressors (TVSS) shall be provided and installed integral to each switchboard assembly. Units shall be UL 1449 listed for installation into switchboards. TVSS devices shall be designed, manufactured, tested, and installed in accordance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1987.

NEMA LS1-1992 Guidelines.

NFPA 20, 70, 75, and 780.

UL 1449 and 1283.

Each TVSS device shall be configured for permanent connection. In-line, series connected components shall not be acceptable. Each TVSS device shall utilize metal oxide varistors (MOV) connected in parallel.

2.5.01 Device Performance. The minimum surge current capability for each device shall be:

	L-L	L-N	L-G	N-G
Switchboards	250,000 A	250,000 A	250,000 A	250,000 A

The minimum UL 1449 rating shall be (inclusive of disconnect):

	L-L	L-N	L-G	N-G
Switchboards	2000 V	1000 V	1000 V	800 V

Each unit shall have a maximum continuous operating voltage (MCOV) greater than 115 percent of the nominal system operating voltage for L-L, L-N, L-G, and N-G.

Each unit shall be capable of suppressing a Category B3 impulse at less than 500 volts. Each unit shall be UL 1283 listed as an electromagnetic interference filter. Electromagnetic filtering shall provide insertion loss with a system noise attenuation of 55 dB from 100 kHz to 100 MHz when tested per 50 Ohm insertion loss method as defined by MIL 220A.

Each unit shall incorporate 200 kAIC rated fusing and shall monitor all modes of protection inclusive of N-G and provide indicator lights (one green and one red LED) on the front cover of the enclosure and an indicator light on each module (inclusive of N-G) to individually monitor each module for failure.

2.5.02 Testing. Contractor shall provide the following test data for each unit:

Third party testing from a nationally recognized testing laboratory (NRTL) verifying that the total surge current can be passed through the fuse with no charring, flames, or projection of materials. Testing of the fuse only will not be acceptable for this requirement. Testing shall indicate the lowest possible surge that can disrupt the fusing.

Third party, NRTL testing verifying the fault current withstand rating of the fusing employed. Testing shall be conducted in both high and low impedance fault conditions and shall confirm no charring, flaming, or projection of materials.

Life cycle testing per ANSI/IEEE C62.41 and C62.45 with fusing in place for category C3 transients (20 kV at 1.2 x 50 microseconds and 10 kV at 8 x 20 microseconds).

2.6 CONSTRUCTION. All equipment furnished under this section shall be designed and constructed in accordance with the following requirements:

2.6.01 Enclosure. The switchboard shall be of deadfront, modular type construction with the required number of vertical sections bolted together to form one rigid, metal-enclosed unit as required. All sections shall be aligned in both front and rear. The switchboard frame shall be of formed UL gauge steel, rigidly bolted together to support all cover plates, buses, and circuit breakers. Steel base channels shall be bolted to the frame. Each section shall have a removable top plate and an open or a barriered bottom for installation and termination of conduit. All front covers shall be removable with a single tool and all doors shall be hinged, with removable hinge pins.

Switchboard enclosures shall be NEMA Type 1 indoor, NEMA Type 3R outdoor, or NEMA Type 3R outdoor walk-in as indicated.

Switchboard connections shall be made in the front, or in the rear, as indicated. Access to the switchboard shall from the front, or from the rear as indicated.

2.6.02 Main Bus. The main bus shall be tin-plated copper and shall be of sufficient size to limit the temperature rise to 150°F (65°C), based on UL tests. Ampere rating, and bus fault rating shall be as indicated on the drawings. End sections shall be predrilled for units to be added in the future.

2.6.03 Neutral Bus. When indicated, a tin-plated copper neutral bus shall be provided through all vertical sections and shall be rated full capacity.

When indicated, the incoming line section shall be equipped with a neutral bond lug suitable to bond the service entrance neutral conductors. The service entrance neutral pad shall be equipped with a main bonding jumper to the switchboard ground bus in accordance with the National Electrical Code.

2.6.04 Ground Bus. The ground bus shall extend the entire length of the switchboard and shall be firmly secured to each vertical section. A ground lug shall be provided at each end of the ground bus for connection to building grounding system with 4/0 AWG bare copper cables. Other ground lugs for feeder circuits shall also be supplied as indicated on the drawings.

2.6.05 Molded Case Circuit Breakers. Molded case circuit breakers shall be individual or panel mounted as indicated. Circuit breakers shall be rated to interrupt and withstand an available fault current at the system line voltage as indicated. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically tripfree. When required, circuit breakers shall be thermal magnetic or shall be furnished with a solid-state electronic trip unit complete with built-in current transformers. The ampere rating of the trip unit shall be as indicated on the drawings.

The trip unit shall have adjustable settings for continuous amperes, instantaneous pickup, and short-time pickup. When required, the trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Circuit breakers indicated to be rated less than 100 amperes shall be thermal-magnetic types.

When indicated, built-in ground fault protection shall have adjustable pick-up ratings not exceeding 1,200 amperes, time delay adjustable from 0.1 to 0.5 seconds, and a neutral ground fault current transformer.

The solid-state electronic trip breakers shall have built-in test points for testing long delay, instantaneous, and ground fault functions of the breaker by means of a 120 volt ac operated test kit.

2.6.06 Insulated Case Power Circuit Breakers. Insulated case power circuit breakers shall be fixed or drawout type with a manually or electrically operated stored energy mechanism as required. The insulated case breakers shall be UL listed for operation at 100 percent of continuous current rating. The circuit breakers shall be rated to interrupt and withstand an available fault current as indicated, at system line voltage, as required. The breaker control faceplate shall include color-coded visual indicators for open and closed positions as well as mechanism charged and discharged positions. Manual push buttons shall be provided for opening and closing the breaker.

Each breaker shall be furnished with a solid-state tripping system consisting of three current sensors, a solid-state trip device, and shunt trip. The solid-state element shall have long delay current pickup, short delay pickup, instantaneous pickup, ground fault pickup and fault trip indicators. All elements of the solid-state trip device shall be of the sealed potentiometer type providing adjustable current pickup in percentage of current sensor primary rating and time delay adjustments. The current sensor primary ampere rating shall be as indicated on the drawings.

The breaker shall have built-in test points for testing long delay, short delay, instantaneous, and ground fault functions of the breaker by means of a 120 volt ac operated test kit.

2.6.07 Shop Painting. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touch up of damaged coatings.

The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.

2.7 ACCESSORIES.

2.7.01 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.8 SHOP TESTS. After the equipment has been completely assembled, it shall be shop tested for general operating conditions, circuit continuity, and high potential and other standard tests for the particular class of equipment as defined by industry standards. Four certified copies of the test results shall be submitted to Engineer before the equipment is shipped.

PART 3 - EXECUTION

3.1 INSTALLATION. Installation will be in accordance with the drawings, specifications, and the manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL.

3.2.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting conduit or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

3.3 FIELD TESTS. After completion of the installation, a qualified factory service representative shall verify that the settings of all protective devices are as recommended in the coordination study, make all adjustments, approve the installation, and test the ground fault system. The ground fault system testing shall satisfy the requirements of the National Electrical Code. Certified copies of the test report shall be furnished to the Owner and the Engineer at the completion of the testing.

End of Section

SECTION 16480

600 VOLT CLASS MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE. This section covers motor control center equipment that shall be furnished and installed as specified herein and as indicated on the drawings.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Engineer notes exceptions.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

1.2.03 Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thickness so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.2.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

AISI	American Iron and Steel Institute
ANSI	American National Standards Institute

AWG	American Wire Gage
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
UL	Underwriters' Laboratories

1.2.05 Governing Standards. All equipment furnished under this section shall be designed, constructed, and tested in accordance with NEMA ICS 2 and UL 845.

Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of the Contractor. In the event, no third-party testing laboratory provides the required listing; an independent test shall be performed at the Contractor's expense. Before testing, the Contractor shall submit a copy of the testing procedure that will be used in evaluating the equipment.

1.2.06 Nameplates. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors. Nameplates shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/8 inch (10 mm) high for compartment identity and 3/16 inch (5 mm) high for other information.

Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1.2.07 System Characteristics. This equipment will be connected to a system with characteristics as indicated on the drawings.

1.3 SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor control center shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The drawings and data for motor control centers shall include, but shall not be limited to, the following:

Drawings and weight.

Unit wiring diagrams indicating devices, connections, and terminal designations.

Interconnection diagrams.

Control schematic diagrams.

Circuit breaker time-current characteristic curves.

When transient voltage surge suppressors are indicated, submittals shall include manufacturer's catalog and specification data, including device dimensions, weight, material composition, and connection diagrams. Documentation shall be provided indicating the file number of compliance with UL 1449 listing requirements and results of independent, third party NRTL certification of listed surge ratings. The test results submitted shall include UL file number, date or report, product covered, electrical ratings, voltages, phases, modes of protection, nomenclatures, and UL 1449 ratings with and without disconnect device.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals.

Operation and maintenance manuals shall include the following:

Assembly, installation, alignment, adjustment, and checking instructions.

Lubrication and maintenance instructions.

Guide to troubleshooting.

Parts lists and predicted life of parts subject to wear.

Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

Test data and performance curves, where applicable.

The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 COORDINATION STUDY. When a coordination study of the power distribution system will be conducted, in accordance with Master Specification Section 16050, Electrical General Requirements, the initial equipment drawing submittal shall include the circuit breaker coordination curves for the main breaker(s), the tie breaker, the largest circuit breaker utilized in a combination starter, and the smallest circuit breaker provided as a part of the motor control center assembly.

1.6 SHIPPING, STORAGE, AND HANDLING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Each motor control center assembly shall be a product of a manufacturer of industrial motor starter and circuit breaker equipment who has supplied such equipment both individually and together as feeder breakers, starters, and combination starters for at least 5 years.

The equipment shall be manufactured by Allen-Bradley, Cutler-Hammer, General Electric, Siemens Energy & Automation, Square D, or approved equal.

2.2 CONSTRUCTION. Each control center shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the drawings or specified herein.

Control centers shall have adequate bus bracing and combination starter ratings of 42,000, 65,000, or 100,000 amperes compatible with anticipated short circuit current.

Control centers connected Power Company feeders shall be rated for service entrance duty.

Control center enclosures shall be NEMA Type 1-Gasketed, NEMA Type 12-Industrial, or NEMA Type 3R, suitable for the environment in which they will be installed.

2.2.01 Vertical Sections. The control center shall consist of standardized, freestanding structures bolted together to form a single dead-front panel assembly containing combination motor control units; feeder units; transformers; lighting panels; and metering, relaying, and interlocking, and miscellaneous control devices, as indicated on the drawings. A removable lifting angle shall be mounted on the top of each shipping group. Removable front and rear bottom channel sills shall extend the full width of the motor control center.

Each vertical section shall be 90 inches (2250 mm) high, not less than 20 inches (500 mm) wide, and not less than 20 inches (500 mm) deep. Each 20 inch (500 mm) wide standard section shall have all necessary hardware and busing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Removable rear plates shall be sectionalized so that it is unnecessary to handle any plate larger than the section width or one-half the section height.

Cable entry shall be provided at top, bottom, or both as indicated.

2.2.02 Compartmented Units. Each vertical section shall be constructed of modular components of various sizes. The modular components shall be designed to accommodate not more than six Size 1 or Size 2 full voltage combination motor starters per vertical section.

Removable circuit breaker and motor starter units shall be provided with a mechanical interlock to prevent insertion or withdrawal when in the "on" position.

Individual motor starter units, feeder breaker units, transformers, lighting panels, and control device compartments shall be isolated from each other by barriers of metal or a suitable insulating material.

Each vertical section shall have a vertical-wiring trough for power and control wiring, and wiring troughs on top and bottom, which are continuous through the entire control center. Wire ties shall be provided in the vertical wireways unless the wireways are separated from the plug-in units by a permanent wall.

2.2.03 Wiring Labels and Terminal Blocks. All internal wires shall be labeled at each termination. Terminals shall also be identified with labels showing the terminal block and terminal number.

Wiring shall be NEMA Class IIS, NEMA Type B, unless otherwise indicated.

All starter units shall be provided with unit control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.

2.2.04 Main Bus. The horizontal main bus and the vertical bus extensions shall be tin-plated copper mounted on supports formed of materials having high dielectric strength, low moisture absorbency, and high impact strength. The bus shall be rated 600, 800, 1,000, 1,200, 1,600, 2,000, or 2,500 amperes as indicated. The main bus shall extend the full length of the motor control center and shall have provisions for splicing additional sections onto either end. Both horizontal and vertical busing shall be braced against forces resulting from fault current, as required. Ampere rating of the bus shall be as required.

The vertical bus connecting an incoming power feeder cable shall have the same ampere rating as the main horizontal bus. Each vertical bus extension shall be rated 300 or 600 amperes as indicated.

A tin-plated copper ground bus rated 300 amperes shall extend through the entire control center and shall be located where it will not interfere with pulling of external cable. Grounding connections shall be accessible from the front. The ground bus shall be provided with six 0.38 inch (10 mm) holes for each vertical section to accept ground lugs for any loads requiring a ground conductor. A solderless connector shall be provided on the ground bus in each end section for an external ground cable, sized from 1/0 AWG to 250 kcmil (50 to 120 mm^2).

Each vertical section shall have a vertical ground bus. The plug-in units shall engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected.

2.2.05 Neutral Bus. When MCC will be connected to a 4-wire system, a tin-plated copper neutral bus shall be provided through all vertical sections and shall be rated full capacity.

The incoming line section shall be equipped with a neutral bond lug or pad suitable to bond the service entrance neutral conductors. The service entrance neutral pad shall be equipped with a main bonding jumper to the control center ground bus in accordance with the National Electrical Code.

2.2.06 Isolation of Buses. The main bus shall be isolated from the horizontal wiring trough. The entire vertical bus assembly shall be enclosed within grounded steel or glass filled polyester barriers. The barriers shall have openings for power stabs of plug-in units. Shutters shall be provided to close the openings when units are removed.

2.2.07 Combination Magnetic Starters. Control center starters, as indicated on the drawings, shall be breaker combination, magnetic, reduced voltage, or across-the-line type. Starters shall have interrupting ratings as required. Starters shall be provided with the following features:

> Starters shall be 3 phase, 60 Hz contactors with overloads, a 120 volt ac coil, a dry type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.
>
> Contactors shall be NEMA rated and have an 8 hour current rating in accordance with the latest NEMA standards. Contactors of reversing or

multispeed starters shall be mechanically and electrically interlocked.

Spare interlock contacts, whether on the starter or a relay, shall be wired separately to the unit terminal board. One NO and/or one NC contact shall be furnished on each starter.

When indicated, a 3 phase ambient-compensated bimetallic or eutectic alloy style thermal overload relay with external manual reset shall be furnished with each starter.

When indicated, heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss and unbalance protection, trip class selection, Class II ground fault protection, and manual reset.

An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.

Contractor shall match control transformers, overloads, heaters, and minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the drawings. Overload relay elements shall be sized to reflect reduced motor current caused by load-side power factor correction capacitors.

Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.

2.2.08 <u>Combination Solid-State Starters</u>. Control center starters, as indicated on the drawings, shall be breaker combination, solid-state, reduced voltage type. Six back-to-back silicon controlled rectifiers shall be used to provide smooth, stepless motor acceleration. When the motor reaches full speed, a bypass contactor shall close and carry the continuous duty motor current. Starters shall have interrupting ratings as required. Starters shall be provided with the following features:

Starters shall be 3 phase, 60 Hz, with overloads, a 120 volt ac bypass contactor coil, a dry-type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

The bypass contactor shall have an 8 hour current rating in accordance with the latest NEMA standards.

Spare interlock contacts, whether on the starter or on a relay, shall be wired separately to the unit terminal board. One NO and/or one NC contact shall be furnished on each starter.

Starters shall include smooth starting and stopping, adjustable starting torque, adjustable ramp time, inverse time overload current trip, current limit, phase loss protection, and adjustable electronic overloads.

An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.

Contractor shall match control transformers, overloads, and the minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the drawings. Overload relay devices shall be adjusted to reflect reduced motor current caused by load-side power factor correction capacitors.

Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.

When indicated, starters shall include an auxiliary contactor for connection to a load-side power factor correction capacitor. The contactor shall be interlocked to prevent the capacitor from being connected before the bypass contactor has energized.

2.2.09 Variable Frequency Drives. Variable frequency drives shall be provided in the size and quantity shown on the drawings or otherwise indicated. Each variable frequency drive shall be coordinated with the requirements of the driven equipment. Particular attention shall be directed toward the driven equipment torque requirements.

The motor control center supplier shall be responsible for coordinating the VFD with the driven equipment to assure compatibility between the drive and motor. All equipment shall be derated as recommended by the VFD and motor manufacturers for reduced speed operation with an variable frequency controller in addition to any derating requirements specified elsewhere.

Each VFD shall be pulse-width modulated type and shall produce a variable ac voltage/frequency output. Each VFD shall maintain a minimum displacement power factor of 0.95 over the entire speed range, and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

Each VFD shall be equipped with an input line reactor and a full-wave diode bridge rectifier to convert incoming fixed voltage/frequency to a fixed dc voltage. The pulse-width modulation technology shall be of the space vector type, implemented in a microprocessor, which generates a sine-coded output voltage.

The VFD inverter output shall be generated by insulated gate bipolar transistors (IGBT) that shall be controlled by six identical base driver circuits. The VFD shall not induce excessive power losses in the motor. The worst case RMS motor line current measured at rated speed, torque, and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation. Each VFD shall be configurable for automatic and manual reset and shall have a variable carrier frequency to at least 6000 Hz.

When indicated on the drawings, a contactor to switch power factor correction capacitors shall be provided.

2.2.10 Contactors. Contactors for control of bus voltage loads other than motors shall be the same as contactors for combination magnetic starters, except overloads will not be required. Mechanically held contactors shall have 120 volt ac coils with disconnecting contacts. Other contactors shall have 120 volt, continuous duty coils and contacts as required.

2.2.11 Relays and Timers. Auxiliary relays and timers shall have 120 volt, 60 Hz coils for continuous duty in 105°F (40°C) ambient, and 10 ampere, 120 volt ac contacts. Auxiliary relays shall be NEMA rated.

2.2.12 Control Switches and Pilot Lights. Control switches and pilot lights shall be heavy-duty, oil tight construction. Pilot lights shall be transformer type with high intensity push to test LED lamps.

2.2.13 Motor Protection Relay. When shown on the drawings or otherwise indicated, a microprocessor based motor protection relay shall be provided. The relay shall protect against phase loss, phase reversal, voltage unbalance, and under voltage on any one or more phases. The relay shall reactivate after power line conditions return to an acceptable level. Trip and reset delays shall prevent nuisance tripping due to rapidly fluctuating power line conditions. The relay shall be Motor Saver Model 102 by SymCom Inc., or approved equal

2.2.14 Circuit Breakers. Control center disconnects shall be three pole, single-throw, 600 volt, molded-case air circuit breakers. Circuit breakers of combination starters shall be magnetic motor circuit protector type. Feeder circuit breakers shall be thermal-magnetic type and shall be manually operated, with quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration. Thermal elements shall trip the breaker at 125 percent of trip rating. The instantaneous elements of 225 ampere frame and larger breakers shall be adjustable and shall be set at 800 percent of trip rating.

When shown on the drawings or otherwise indicated, main circuit breakers and feeder circuit breakers 225 amperes and larger shall be furnished with a solid-state trip unit complete with built-in current transformers. The ampere rating of the trip unit shall be as indicated on the drawings. The trip unit shall have adjustable settings for continuous amperes, and short-time pickup. The trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Where indicated on the drawings, main circuit breakers shall be provided with instantaneous pickup and integral ground fault protection with shunt trip devices.

2.2.15 Incoming Line Metering Compartment. When shown on the drawings. or otherwise indicated, the incoming line section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Currents, voltages, active power, reactive power, power factor, watt-hours, frequency, and demand values shall be available for display. Total harmonic distortion waveforms shall also be available. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of RS 485 serial communication for remote monitoring. The digital power meters shall have built-in face display and shall be Cutler-Hammer "IQ Analyzer", Multilin PQM, Square D PowerLogic Model 2350, Allen-Bradley “Power Monitor II”, Basler “Energy Transducer”, or approved equal.

Sufficient lengths of communication cable shall be provided for connection of metering units within the motor control center and as indicated on the drawings.

When indicated, the metering package shall be compatible with the metering system software and metering system network as indicated in the Contract Documents. Contractor shall furnish and install applications software for origination and display of all metering unit data and microprocessor-based trip-unit data as indicated in the Contract Documents.

The unit shall have two isolated 4-20 ma selectable outputs.

2.2.16 Miscellaneous. Other items indicated on the drawings shall conform to the applicable provisions of NEMA ICS 2 and UL 845.

2.2.17 Lighting Transformers. Lighting and auxiliary power transformers shall be dry type, with at least two full capacity taps.

2.2.18 Panelboards. Panelboards shall have a main circuit breaker, buses, bolted thermal-magnetic breakers, and provisions for breakers in the sizes, quantities, and poles indicated on the drawings. Breakers indicated to be multiple pole shall be common trip. Circuit breakers shall be fully rated, with an interrupting rating of at least 10,000 amperes, and shall be coordinated with the control center short-circuit rating. Each panel shall be provided with a typewritten directory listing the load identities of all circuits. Six breaker handle clips shall be provided to prevent casual tripping.

2.2.19 Special Panels. Instruments, controls, and accessories shall be mounted either on special doors or on sheet steel panels mounted behind hinged doors, as indicated on the drawings. All panels and hinges shall be sufficiently strong to support the mounted items.

2.2.20 Shop Painting. All iron and steel surfaces, except stainless steel and machined surfaces, shall be plated or shop painted with the manufacturer's standard coating. Finish color for both indoor and outdoor equipment shall be ANSI 61. Back plate color shall be white. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

When equipment is to be installed in exposed outdoor locations, the underside shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.

2.2.21 Space Heaters. Space heaters shall be furnished at the bottom of each vertical section of motor control centers provided with NEMA Type 3R enclosures. The heaters shall be thermally insulated and shall be located to prevent damage or discoloration to painted surfaces. Heaters shall be located where they do not interfere with cable entrances. The heaters shall be controlled by an adjustable thermostat set to cut out when the temperature rises to 90ºF (32ºC) and to cut in when the temperature falls below 85ºF (29ºC) and shall have capacity to maintain the section's interior temperature above dew point. Heaters shall be rated 120 volts ac.

When indicated, space heater wiring, with branch circuit protection, shall be factory installed, with terminals provided for connection of an external power supply.

When indicated, power to space heaters shall be supplied from a panelboard integral to each motor control center. All wiring and branch circuit protection shall be factory installed.

2.3 TRANSIENT VOLTAGE SURGE SUPPRESSION. When shown on the drawings or otherwise indicated, transient voltage surge suppressors (TVSS) shall be provided and installed integral to each motor control center assembly. Units shall be UL 1449 listed for installation into motor control centers. TVSS devices shall be designed, manufactured, tested, and installed in accordance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1987.

NEMA LS1-1992 Guidelines.

NFPA 20, 70, 75, and 780.

UL 1449 and 1283.

Each TVSS device shall be configured for permanent connection. In-line, series connected components shall not be acceptable. Each TVSS device shall utilize metal oxide varistors (MOV) connected in parallel.

2.3.01 Device Performance. The minimum surge current capability for each device shall be:

	L-L	L-N	L-G	N-G
Control Centers	200,000 A	200,000 A	200,000 A	200,000 A

The minimum UL 1449 rating shall be (inclusive of disconnect):

	L-L	L-N	L-G	N-G
Control Centers	2000 V	1000 V	1000 V	800 V

Each unit shall have a maximum continuous operating voltage (MCOV) greater than 115 percent of the nominal system operating voltage for L-L, L-N, L-G, and N-G.

Each unit shall be capable of suppressing a Category B3 impulse at less than 500 volts. Each unit shall be UL 1283 listed as an electromagnetic interference filter. Electromagnetic filtering shall provide insertion loss with a system noise attenuation of 55 dB from 100 kHz to 100 MHz when tested per 50 Ohm insertion loss method as defined by MIL 220A.

Each unit shall incorporate 200 kAIC rated fusing and shall monitor all modes of protection inclusive of N-G and provide indicator lights (one green and one red LED) on the front cover of the enclosure and an indicator light on each module (inclusive of N-G) to individually monitor each module for failure.

2.3.02 Testing. The Supplier shall provide the following test data for each unit:

Third party testing from a nationally recognized testing laboratory (NRTL) verifying that the total surge current can be passed through the fuse with no charring, flames, or projection of materials. Testing of the fuse only will not be acceptable for this requirement. Testing shall indicate the lowest possible surge that can disrupt the fusing.

Third party, NRTL testing verifying the fault current withstand rating of the fusing employed. Testing shall be conducted in both a high and low impedance fault condition and shall confirm no charring, flaming, or projection of materials.

Life cycle testing per ANSI/IEEE C62.41 and C62.45 with fusing in place for category C3 transients (20 kV at 1.2 x 50 microseconds and 10 kV at 8 x 20 microseconds).

2.4 ACCESSORIES.

2.4.01 Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

2.5 SHOP TESTS. The complete control center shall be tested at the factory. All circuits, including power and control, shall be given dielectric tests in accordance with NEMA ICS 2-322.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL.

3.1.01 Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Master Specification Section 01180, Equipment, Parts, and Tools, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting conduit or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the Contract Price.

End of Section

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of all interior and exterior building fixtures, emergency lighting equipment, exit signs, and area lighting as indicated on the Contract Documents, including all associated equipment, devices, and controls necessary for proper operation.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Engineer notes exceptions.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools, shall apply to all equipment furnished under this section.

1.2.03 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.2.04 Governing Standards. All lighting equipment furnished under this section shall be designed, constructed, and tested in accordance with applicable ANSI, NEMA, NEC and UL standards. Fixtures shall be listed and labeled by UL or an equivalent testing laboratory acceptable to the Engineer. Fixtures shall also meet the requirements of the latest edition of the National Appliance Energy Conservation Act (NAECA) and all amendments thereto, Federal Communications Commission

(FCC) Rules and Regulations - Part18, and IEEE Standard 587 for transient protection.

All lighting fixtures with plastic lenses shall comply with the Michigan State Fire Safety Board ruling dated July 22, 1970

1.3 SUBMITTALS. Data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The equipment submittals shall include the following:

Shop drawings for each type of lighting fixture with identity of each item by fixture specification, type/model number, manufacturer and catalog number.

Fixture photometric curves.

Certification of listing by UL.

1.4 SPARE PARTS. Provide the following spare parts, with quantities rounded up to the nearest whole number, ready to install as direct replacements for the same item included in the work specified in the Contract Documents:

DESCRIPTION	QUANTITY
High Intensity Discharge Lamps.	20% of the number of lamps installed
High Intensity Discharge Ballasts.	25% of the number of ballasts installed
High Intensity Discharge Lenses.	10% of the number of lenses installed
Fluorescent Lamps.	25% of the number of lamps installed.
Fluorescent Ballasts.	25% of the number of ballasts installed
Fluorescent Lenses.	10% of the number of lenses installed
Incandescent Lamps.	25% of the number of lamps installed.
Incandescent Lenses.	10% of the number of lenses installed

All spare parts furnished shall comply with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

Submit a list of recommended spare parts in addition to the items listed herein. These spare parts shall be as recommended by the manufacturer for maintenance of each unit. Each item on the list of recommended spare parts shall include a price of the item packaged and delivered to the Owner in Detroit, including all markups, taxes and other costs.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES. Lighting fixtures shall be furnished as described in the fixture schedule in the Contract Documents. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified.

Prismatic lenses on recessed fluorescent fixtures shall be acrylic and shall not be less than 0.125 inch (mm).

Fixtures using metal halide lamps shall have a tempered glass shield below the lamp to contain broken lamp parts and to contain ultra-violet radiation.

Exterior building fixtures shall be factory equipped with waterproof gaskets and dark bronze anodized aluminum frames, unless indicated otherwise on the Contract Documents, and shall be designed to be completely waterproof. The finish shall be free of scratches and other surface blemishes.

Other materials required for the lighting system such as conduit, raceway, wire and cable, support devices, fasteners, and control devices shall be as specified in Master Specification Section 16050, Electrical General Requirements.

2.1.01 Lamps. Provide lamps of the proper type, wattage, voltage, and socket size for all lighting fixtures. Incandescent lamps shall be rated 130 VAC, extended service 2,500 hours rated life. Fluorescent lamps shall be of the energy saving type.

2.1.02 Fuses. Each fixture having a ballast shall be fused according to the ballast manufacturer's recommendations. The fuse shall be wired to the primary ballast lead on the ungrounded side and shall be accessible for replacement.

2-1.03. Ballasts. Provide rapid start, low noise level electronic ballasts for fluorescent type lighting fixtures. Ballasts shall be CBM certified as meeting requirements of ANSI C82.11 with a Total Harmonic Distortion (THD) level of not more than 10 percent.

Ballasts for metal halide fixtures shall be electronic or high power factor , non-PCB regulator type. Ballasts for indoor fixtures shall be rated for operation in 122 F (50 C) ambient. Ballasts for outdoor fixtures shall provide reliable starting down to minus –20 F (-29 C).

Ground ballasts in accordance with NEC and provide in-fixture automatic resetting thermal protection for ballasts and capacitors.

2.2 EMERGENCY LIGHTING UNITS. Emergency Lighting Units shall be self-contained units and shall comply with UL 924. Units shall have a sealed, maintenance-free, lead-acid battery with a 10 year nominal life and special warranty. The battery charger shall be fully automatic, solid-state type with sealed transfer relay. The relay shall automatically turn the lamp on when voltage drops to 80 percent or below and the lamp shall be disconnected when the voltage reaches deep discharge level. When normal voltage is restored, the relay shall disconnect the lamps and the battery shall be recharged and floated on the charger.

2.3 EXIT SIGNS. Exit signs shall be self-luminous type with tritium filled gas tubes rated for 20 year life. Signs shall meet UL 924 and NFPA 101. Signs shall have a completely sealed housing and shall be furnished with tamperproof hardware.

PART 3 - EXECUTION

3.1 GENERAL. All work shall be installed as indicated on the drawings, and in accordance with the manufacturer's diagrams and recommendations, except where otherwise indicated.

3.2 LIGHTING FIXTURE INSTALLATION. The Contract Documents indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

Conduit and wire for lighting fixture installation that is not shown on the Contract Documents shall be sized, furnished and installed by the Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to fluorescent lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch (mm) for lighting fixture installation.

Support recessed fixtures on ceiling system structural elements rather than its surface materials such as tiles, plaster, drywall, etc. Install suitable sealing gaskets where light leaks occur through gaps between the recessed fixture trim and adjacent surface.

Hang suspended fixtures plumb, with continuous rows of fixtures in alignment. Unless indicated otherwise on the Contract Drawings, mount suspended fixtures in each room or area at the same height regardless of varying clear height conditions.

Install Exit Signs directly over doorways, for those doors as indicated on the Contract Drawings. Center fixtures over doorway and install fixtures to clear door and associated hardware.

3.2.01 Fixture Relamping. Lamp those permanent light fixtures, as used for temporary lighting during construction, with Contractor's own lamps. Remove temporary lamps at acceptance of Work and install new proper lamps in each fixture. New lamps shall be in perfect working order.

3.2.02 Fixture Cleaning. Vacuum accumulations of dust from suspended light fixtures, as well as recessed style fixtures. Do not air blow dust from fixtures. Dusting of fixtures with dust cloths may be performed where accumulation of dust is light.

Follow the cleaning procedures as recommended by the fixture manufacturer for new fixture cleaning for construction work practice. Use only those products for cleaning as outlined in the fixture manufacturer's literature.

End of Section

SECTION 16722

CLOSED CIRCUIT TELEVISION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of closed circuit television equipment (CCTV) systems, including all associated equipment, devices, and controls necessary for proper operation.

The Contractor shall furnish the design of the system.

1.2 GENERAL. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Engineer notes exceptions.

The design of the system shall provide for CCTV surveillance alarm of the areas, locations, doors, gates etc. indicated. The design shall consist of, but shall not be limited to, an analysis of ambient temperatures, noise levels, light intensities, and environmental conditions (wet, dusty, oily, corrosive, hazardous, etc.) in the various areas; selection of the appropriate cameras, housings, video monitors, and video recorders; and the design of the necessary wiring and mounting configurations.

1.2.01 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

The system design, equipment, installation, and installation supervision furnished under this section shall be provided by a manufacturer or supplier who has been engaged in the business of supplying this type of equipment for at least 5 years.

1.2.02 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.03 Governing Standards. All wiring and components shall meet the applicable requirements of the NEC.

All components installed in hazardous areas shall be listed by Underwriter's Laboratories or Factory Mutual.

1.2.04 Nameplates. Major components of equipment shall be identified with a permanently affixed nameplate bearing the manufacturer's name and address, and type or style and catalog number of the item. Nameplates shall have black baked enamel letters on anodized aluminum plate.

1.2.05 Tags. Keys and locks, where required, shall be furnished with tags bearing stamped identification number. Cable and conduit runs, wiring circuits, and all spare parts supplied to maintain the system shall be furnished with hard phenolic or stainless steel tags.

1.2.06 Power Requirements. Primary power supply to all system components will be 120 volts, 60 Hz, single phase. Contractor shall be responsible for meeting all additional power supply requirements and shall furnish any transformers or other power supply equipment needed.

1.3 SUBMITTALS. Complete wiring diagrams; assembly and installation drawings; detailed specifications; and data covering the design of the system shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall also be submitted in accordance with Master Specification Section 01080, Project Submittals. The equipment submittals shall include the following:

A complete description of all system components, including certification of listing by UL or FM.

Complete sequence of operation for all functions of the system.

Complete system wiring diagram for all components and interfaces to equipment supplied under other sections or by the Owner.

Location drawings for all system components.

A listing of the manufacturer's representatives responsible for installation and servicing.

Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. The security system shall be supplied by Simplex Time Recorder Company, Burle, Wells Fargo Alarm Services, or approved equal.

2.2. CCTV SYSTEM.

2.2.01 CCTV Cameras. CCTV cameras shall be 1/2 inch (12.5 mm) or 2/3 inch (17 mm) format CCD type monochrome cameras and shall be powered from a 120 volt ac source. If necessary, a transformer shall be provided for each camera to step down the supply voltage. Each indoor camera shall be equipped with a motorized auto-iris 8-48 mm (6x) zoom lens, and each outdoor camera shall be equipped with a motorized, auto- iris, 11-110 mm, (10x) zoom lens, all with suitable connectors or adapters. An extruded aluminum indoor/outdoor enclosure shall be provided for each outdoor camera. Cameras installed in chlorine rooms shall be provided with sealed, stainless steel enclosures.

Each camera shall be provided with a pan and tilt drive assembly suitable for outdoor use and capable of 355 degree pan. The pan and tilt assemblies shall operate from the same 120 volt ac source as the camera. Suitable mounting hardware shall be provided for both rooftop and wall-mounted camera assemblies.

2.2.02. Receiver Drivers. A receiver/driver assembly shall be furnished and installed near each camera for remote control of camera pan, tilt, focus, and zoom, based on commands received from the remote control equipment specified in this section. Signals shall be in a serial format that allows receiver/drivers to be arranged in a star or a daisy chain configuration with respect to the control equipment. Receiver/drivers shall be housed in a NEMA Type 4 enclosure and shall operate from 120 volts ac. Outputs for camera control shall be at a voltage suitable for the pan/tilt unit or lens.

2.2.03 CCTV Monitors. CCTV monitors shall be furnished and installed at the locations indicated on the drawings.

When a CCTV monitor is to be mounted in the control room console, mounting requirements shall be coordinated with the console supplier.

Monitors shall be 9 inch (230 mm), 13 inch (330 mm), or 16 inch (405 mm) monochrome units, as indicated, and shall be compatible with the CCTV equipment supplied. The monitors shall have a minimum resolution of 700 lines, and shall be provided with integral controls for adjusting contrast and brightness, and shall operate from a 120 volt ac, 60 Hz power supply.

2.2.04. Video Recorders. Video recorders shall utilize a standard VHS videocassette tape and shall operate from a 120 volt ac source. Recorders shall be time-lapse type that can record up to 700 hours of time-lapse video on a single VHS tape. Recorders shall be capable of accepting an alarm input and automatically initiating recording when the alarm is received and shall be programmable to initiate recording on a time of day/day of week basis.

The recorder shall be provided with a 16-channel multiplexer which allows viewing and recording of up to 16 video channels on a single VCR. The multiplexer shall be compatible with the VCR and monitors provided, and include a decoding mode to recover recorded video from any camera connected to the system.

2.2.05 Switcher/Controller Units. A switcher/controller unit shall be furnished and installed where indicated on the drawings. The switcher/controller unit shall be compatible with all other CCTV components to allow remote operation of cameras and monitors. The switcher/controller shall be suitable for manual and automatic camera sequencing and switching, remote control of camera functions such as pan, tilt, zoom, and focus, and shall transmit video output signals to two, four, or eight monitors as indicated.

Each switcher/controller shall accept 12 or 24 camera inputs, as indicated, and shall allow any of the inputs to be selected for display/control on the attached monitors. The switcher/controller shall allow manual, automatic sequence, or alarm initiated selection of the cameras. Automatic sequences shall allow the user to select a different camera sequence for each monitor output, with programmable dwell time for each camera in the sequence. Active input information shall be output to any monitor connected to the switcher/controller.

The switcher/controllers shall operate from a 120 volt ac, 60 Hz source, and shall be provided with 5 day battery backup. Switcher/controllers shall be suitable for desktop or rack mounting.

2.2.06 Four-Channel Video Multiplexer. The four-channel video multiplexer shall be a microprocessor based device that digitizes inputs from four video sources, reduces the images to one-fourth the original size, and produces a video output of the four images in four quadrants on a single monitor. The multiplexer shall provide on-screen numeric indication of the images and shall allow any image to be selected for full-screen viewing.

2.2.07 Video Compression Units. A video compression transmitter/receiver pair shall be provided when indicated, to interface the CCTV system with remote cameras over a serial communication link. The transmitting unit shall accept up to 10 full video inputs and shall digitize and compress the signals for transmission over a serial communications link with a bit per second transmission rate as indicated. The receiver shall accept compressed video signals from the transmitter and convert the signals to corresponding analog signals for input to the CCTV switcher/controller.

Compression units shall be suitable for operation at 120 VAC. The transmitter shall have at least 10 control outputs that correspond to control inputs at the receiver. Contractor shall coordinate the pan, tilt, and zoom controls of all cameras, with the video compression transmitter/receiver controls, to ensure that remote cameras can be controlled from the switcher/controller.

Video compression units shall be ADPRO "Model VST 10CA", or approved equal.

2.2.08 Power Supplies and Transformers. Power supplies and transformers shall be furnished as needed to provide power to the CCTV equipment. Contractor shall be responsible for coordinating power supply or transformer connections and cable routing.

A dedicated 120 volt ac, 60 Hz power supply shall be provided for powering each camera, receiver/driver, pan/tilt/zoom, and lens.

2.2.09 Enclosures. All components supplied as part of the CCTV system shall be mounted in a NEMA rated enclosure designed for use in the environment indicated on the electrical drawings. All enclosures indicated to be located in hazardous areas shall be FM approved or UL listed for use in the specified environment.

All enclosures shall be fitted for direct connection of conduit and shall be designed for wall or column mounting unless otherwise specified or indicated on the drawings. Any special mounting components or brackets shall be provided by CONTRACTOR.

2.3 CABLE AND RACEWAYS.

2.3.01 Cable . Cable used in the CCTV system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations. All cable required for the system, including 120 volt ac power cable, when indicated, shall be furnished by Contractor.

2.3.02 Raceways. All cable shall be installed in conduit furnished under this section. All conduits, including conduit for 120 volt ac power cable, when indicated, shall conform to the applicable paragraphs of Master Specification Section 16050, Electrical General Requirements.

PART 3 - EXECUTION

3.1 GENERAL. All work shall be installed as indicated on the drawings, and in accordance with the manufacturer's diagrams and recommendations, except where otherwise indicated.

Installation of equipment and devices that connect to equipment furnished under Master Specification Section 01180, Equipment, Parts, and Tools, or furnished by Owner, shall be closely coordinated with the suppliers of the equipment and with Owner.

After completion of the installation, Contractor shall clean the inside and the outside of all CCTV equipment and shall remove all dirt and debris from the site.

Contractor shall provide on-site supervision of installation.

3.1.01 Cable. Cable shall be installed as described in the cable installation paragraphs in Master Specification Section 16050, Electrical General Requirements. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

3.1.02 Raceways. Conduit shall be installed as described in the conduit installation paragraphs in Master Specification Section 16050, Electrical General Requirements.

3.1.03 Testing. Contractor shall notify Engineer at least 30 days before the performance and acceptance tests are to be conducted. The tests shall be conducted in the presence of Engineer and Owner. Contractor shall furnish all instruments and personnel required for the tests. A complete test report and letter of completion shall be submitted to Engineer. The testing shall be conducted by, or under the supervision of, a qualified representative of the system manufacturer and shall include each system component and its interaction with other components. Contractor shall submit the proposed testing procedure with the preliminary operation and maintenance manuals.

End of Section

SECTION 16740

TELEPHONE (PAX) SYSTEM

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of an inward direct dial, inside voice, Private Automatic Exchange (PAX) telephone system including, but not limited to, an attendant's console, a switching system, inside wiring, telephone sets, and all associated equipment, devices, and controls necessary for proper operation.

The telephone system components shall be designated and shall be located as shown on the drawings.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Stipulations. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment furnished under this section.

1.2.02 Coordination. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

1.2.03 Contractor's Qualifications. In the acquisition, installation, and follow-up of the telephone system, the firm selected shall be fully capable and experienced in the services offered. To assure Owner of a system having long life and long-term vendor support, this system shall be provided by a manufacturer or supplier who has been engaged in the business of supplying this type of equipment for at least 5 years.

Contractor shall be capable of providing full system warranty and immediate maintenance service for at least one year following system acceptance by Owner.

1.2.04 Governing Standards.

EIA	Electronic Industry Association
FCC	Federal Communications Commission

FM	Factory Mutual
ICEA	Insulated Cable Engineers Association
NEC	National Electric Code, NFPA-70
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Assocation
UL	Underwriters Laboratories

1.2.05 Power Supply. Power supply to equipment will be 120 volts, 60 Hz, single phase.

1.3 SUBMITTALS. Complete wiring diagrams; assembly and installation drawings; detailed specifications; and data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with Master Specification Section 01080, Project Submittals. The equipment submittals shall include the following:

Complete sequence of operation for all functions of the system.

A listing of the manufacturer's representatives responsible for installation and servicing.

Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS. Acceptable manufacturers and products shall be as specified herein, or shall be equivalent products of manufacturers regularly producing digital telephone systems and equipment.

2.2 TELEPHONE SYSTEM. The telephone system shall consist of a digital electronic modular switching system with capacity for at least three central office (CO) lines and twelve stations. The system shall support standard telephone stations, personal computer modems, and facsimile machines, or any other device that works with conventional telephone lines.

The system shall have, at a minimum, the capabilities of call hold, call transfer, and three-way conference calling. The system console shall be Panasonic KX-T7235, or approved equal, and shall be located as indicated on the drawings.

The electronic modular switching system shall be Panasonic "Model KX-TD308", or approved equal, and shall have capability for caller ID, call forwarding, and automatic redial features.

2.2.01. Handsets. All single-line telephone instruments shall be metal-based and the shells shall be composed of a durable, industry-standard, hard-finish plastic material. All single-line telephones shall be fully modular. All instruments provided shall be equipped with adjustable ringers. The color of all instruments shall be ivory.

Contractor shall furnish eight single-line telephones, four desk type and four wall-mounted type.

2.2.02 Cables. Cables which interconnect interior distribution centers shall conform to ICEA S-80-576. Where required, cable shall be UL classified low smoke and low flame for use in air plenums in accordance with NFPA 70. Cables which terminate at each station jack shall conform to ICEA S-80-576. Each cable shall be a minimum of four copper pairs of 22 or 24 AWG or two optical fibers.

2.2.03 Raceways. Unless indicated otherwise, all cables shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of Master Specification Section 16050, Electrical General Requirements.

2.2.04 Station Jacks. Station jacks shall be modular four-wire type and conform to FCC Part 68.

2.2.05 Station Line Cord. Station line cord shall be modular between the station jack and the base of the instrument, at least 6 feet in length, and shall conform to FCC Part 68.

PART 3 - EXECUTION

3.1 GENERAL. All work shall be installed as indicated on the drawings and in accordance with the manufacturer's diagrams and recommendations except where otherwise indicated.

Installation of equipment and devices that connect to equipment specified in Master Specification Section 01180, Equipment, Parts, and Tools, or furnished by the Owner, shall be closely coordinated with the suppliers of such equipment or with the Owner.

Contractor shall provide on-site supervision of installation.

3.1.01 Cable. Cable shall be installed as described in the cable installation paragraphs in Master Specification Section 16050, Electrical General Requirements.

The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

3.1.02 Raceways. Conduit shall be installed as described in the conduit installation paragraphs in Master Specification Section 16050, Electrical General Requirements.

3.1.03 Testing. The Contractor shall notify Engineer at least 30 days before the performance and acceptance tests are to be conducted. Contractor shall submit the proposed testing procedure prior to the notification. The tests shall be conducted in the presence of Engineer and Owner. The System Supplier shall furnish all instruments and personnel required for the tests. A complete test report and letter of completion shall be submitted to the Engineer. The testing shall be conducted by, or under the supervision of, a qualified representative of the system manufacturer and shall include each system component and its interaction with other components.

3.1.04 User Training. At the convenience of Owner, Contractor shall provide operational training for all user personnel. Contractor shall provide skilled personnel, materials, and training devices necessary for such training during a one day seminar at a location designated by the Owner. The training seminars shall be conducted so that all user personnel will learn the function and operation of the equipment and features assigned for general use. This on-the-job training shall include all the communication equipment supplied under this specification. All applicable feature-related terms and conditions shall be fully defined, explained, and demonstrated. User training shall be scheduled not more than 14 calendar days prior to completion of system installation.

End of Section

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DIVISION 17 – INSTRUMENTATION AND CONTROLS

PAGE NO.

SECTION 17100

COMPUTER CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of a computer control system as designated and as required.

The system shall be furnished as specified, complete with all software, human machine interface (HMI) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training required for proper operation.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. When required, the General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

The supplier shall have as a minimum 5 years in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

1.2.02 Drawings. The drawings indicate locations and arrangements of equipment and may include input/output lists and block and one-line diagrams showing connections and interfaces with other equipment. The input/output (I/O) lists are included as required.

1.2.03 Codes, Permits and Agency Approvals. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where required by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories or other testing organizations acceptable to the governing authority. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment required by the authorities.

1.2.04 Coordination. Systems supplied under this section shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

1.2.05 Related Equipment and Materials. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

1.3 GENERAL REQUIREMENTS. The drawings and specifications indicate the extent and general arrangement of the systems. If any departures from the drawings or specifications are deemed necessary by Contractor, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

The specifications describe the minimum requirements for hardware and software. Where Contractor's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

1.3.01 Governing Standards. When required, all equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

1.3.02 Dimensional Restrictions. Layout dimensions will vary between manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer. At least three feet of clear access space shall be provided in front of all components of the computer control system components.

1.3.03 Workmanship and Materials. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

1.3.04 Abbreviations. Reference to standards and organizations in the Specifications shall be by the following abbreviated letter designations:

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gage
FCC	Federal Communications Commission
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.4 SUBMITTALS. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with Master Specification Section 01080, Project Submittals. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the drawings shall be referenced where applicable.

1.4.01 First Stage Submittal. The first stage submittal shall include the following items.

A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by Contractor and this specification.

Product catalog cut sheets on all hardware items, clearly marked to show the model number, optional features, and intended service of each device.

A brief, concise description of the proposed system, including major hardware and software components, field services, and personnel training.

A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.

Drawings showing floor space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access.

Environmental and power requirements, including heat release information for each equipment item.

Standard system engineering and user manuals describing the use of the system and application programming techniques for creating reports, graphics, database, historical records, and adding new process I/O nodes to the system.

Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

A copy of the proposed software licenses for all software associated with the system.

1.4.02 Second Stage Submittal. Before any equipment is released for shipment to the jobsite and before factory testing is scheduled, the following data shall be submitted.

At Contractor's option, the first and second stage submittals may be combined.

Detailed functional descriptions of all software modules specified and furnished as part of Contractor's standard system. The descriptions shall be identified with the applicable specification paragraph.

Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If panel terminal designations, interdevice connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the jobsite.

Review of drawings submitted prior to the final determination of related equipment shall not relieve Contractor from supplying systems in full compliance with the specific requirements of the related equipment.

Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites.

1.4.03 Third Stage Submittal. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment furnished. Operation and maintenance manuals shall be submitted in accordance with Master Specification Section 01160, Training and Operation & Maintenance Manuals. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted.

1.5 PREPARATION FOR SHIPMENT. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. Contractor shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the Work Site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1.6 DELIVERY, STORAGE, AND SHIPPING. Shipping, handling and storage shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.7 SPARE PARTS. Spare parts and consumable items shall be provided as required.

1.7.01 Packaging. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

1.7.02 Replacement. Contractor may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS. All equipment furnished under each attached section referenced in SCOPE is a part of this section and shall be selected by Contractor for its superior quality and intended performance. Equipment and materials used shall be subject to review.

2.1.01 Standard Products. The systems furnished shall be standard products of Contractor. Where two or more units of the same type of equipment are required, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service.

2.2.01 Y2K Compliance. All hardware, software, and firmware, furnished as stand alone components, or as embedded portions of other systems, shall process information related to dates in a manner so that information for dates beyond December 31, 1999, does not cause false operation, require operator intervention, or otherwise impact the function of the device.

2.2.02 Factory Assembly. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impracticable.

2.2.03 Expandability. The system shall be capable of expansion as required.

2.3 POWER SUPPLY. Unless otherwise required, power supply to all equipment will be 120 volts, 60 Hz, single phase. Contractor shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with Master Specification Section 16050, Electrical.

2.3.01 Facility Distribution System. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of ±10 percent and harmonics up to the limits of IEEE 519 without affecting operation. Contractor shall provide voltage conditioning or filtering equipment if necessary to meet the requirements specified.

2.3.02 Power Supplies. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected.

2.3.03 Surge Withstand. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.

2.3.04 Uninterruptible Power Supply. When required, an uninterruptible power supply (UPS) will be furnished hereunder to power the equipment indicated on the drawings or will be furnished under another section. Contractor shall be responsible for coordinating the size of the UPS unit with the equipment furnished hereunder, and shall advise Contractor if a unit of higher capacity is required.

2.4 SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS. The equipment provided for the computer control system shall be suitable for the service conditions required by the applicable equipment section.

All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

2.4.01 Ambient Temperature. All system equipment located in air conditioned rooms shall be suitable for operation in ambient temperatures from 50°F to 95°F (10°C to 35°C) and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non air conditioned indoor areas shall be suitable for an ambient temperature range of 32°F to 122°F (0°C to 50°C) and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range as required and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where required.

2.4.02 Deleterious Effects. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. Contractor shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

2.4.03 Noise Level. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

2.4.04 Lightning Protection. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2.4.05 Grounding. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the drawings shall be modified as recommended by Contractor.

2.4.06 Surge Arresters. Surge and lightning arresters shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

All power connections to RTUs, PLCs, DCUs, instruments and control room equipment. Surge arresters shall be similar to Transtector "ACP-100-BW".

All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede or interfere with the use of smart transmitter calibration/communication.

All metallic conductor local area network and data highway termination points, where any part of the data highway cable is routed outside of the building envelope.

All radio antenna leads.

All telephone lines at points of connection to the system. Protection devices shall be similar to Transtector FSP/LMP series.

2.5 SYSTEM SOFTWARE CONFIGURATION. The system software will be configured by Engineer, Owner, or a Configuration Contractor. Contractor shall be responsible for the following configuration support tasks:

Furnish and install the necessary operating system software, utilities, and all standard software packages. All software provided shall be fully configured for use as required by this contract. This configuration should include but not limited to, security access from the Administrator functionality to the Operator functions, printing functions (including graphics, reports, system documentation parameters, etc.), reporting functions, and historical interface and historical data accessibility.

Furnish and apply all standard communications software and develop any custom communications software needed for the components of the system to communicate information as indicated on the functional block diagram on the drawings.

Configure the hardware and provide any required firmware or software programming associated with the hardware, configuration such as DCU, PLC, and RTU device address assignments.

Provide the services of an experienced applications engineer for the number of 8-hour day visits as required, at Owner's or Engineer's facilities, to assist with the configuration. One of these visits shall be scheduled to coincide with the delivery of equipment for configuration. The remaining visits shall be scheduled with Engineer and Owner.

Provide the services of the Applications Engineer for telephone consultation and trouble shooting from Contractor's facility for the total number of hours as required.

Provide early shipment of the terminal and hardware equipment required for configuration of the system as defined herein. This equipment shall be delivered to Owner's or Engineer's offices as required, but not before submittal information and drawings for the equipment have been approved. Contractor shall also be responsible for subsequent retransport of this equipment to the project site.

Provide configuration information to Engineer at least two weeks before the shipment of equipment. Include specific I/O address numbering schemes for all field I/O points, database tag numbering format, address numbers of points required for internal use, and other information required to begin database, HMI, and PLC, RTU, or DCU programming.

Provide complete startup, checkout, and calibration of all system hardware and I/O specified herein.

Provide any programming required to implement the features and functions described herein that are not a standard part of the system software. Software that must be Engineer-Owner produced custom programming code is unacceptable.

2.6 SOFTWARE DOCUMENTATION. Contractor shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the magnetic media backup. Software documentation shall consist of the following principal items.

One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.

Two complete back up copies of system and application software in executable format on magnetic media compatible with the system furnished.

Three sets of user reference manuals for all standard system and application software.

One set of user reference manuals for all operating system software.

Three sets of printed as-built reference documentation for any special software provided specifically for this contract.

For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. There should be one set of this documentation for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2.7 SOFTWARE LICENSE. All software programs supplied as a standard part of Contractor's products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of Contractor's software license are subject to review and approval by Owner and Engineer.

2.8 INSTALLATION TEST EQUIPMENT. All necessary testing equipment for calibration and checking of system components shall be provided by Contractor. Contractor shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS. The installation of equipment furnished hereunder shall be the responsibility of Contractor or his subcontractors.

3.1.01 Field Wiring. Field wiring materials and installation shall be in accordance with Master Specification Section 16050, Electrical.

3.1.02 Instrument Installation. Additional requirements for mounting, piping, and calibration of field instruments are described in Master Specification Section 17500, Instrumentation General Requirements.

3.1.03 Salvage of Existing Equipment. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner, or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.

Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3.2 SYSTEMS CHECK. When required, Contractor shall provide the services of a field manager and a trained and experienced field supervisor to assist the installation Contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

3.2.01 Field Manager. When required, Contractor shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Engineer and Owner by phone or on site for the duration of this project.

3.2.02 Field Inspection at Delivery. When required, the field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

3.2.03 Training for Installation Personnel. When required, the field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment.

3.2.04 Field Inspection Prior to Start Up. After installation and wiring connections are complete, the field supervisor, with additional Contractor and Contractor personnel as required, shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended.

3.2.05 Analog Signals. Analog input signals shall be simulated at the transmitting source, and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.

3.2.06 Discrete Signals. Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

3.2.07 Devices by Other Suppliers. If interrelated devices furnished by other suppliers or under other contracts, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

3.2.08 System Check Out Report. A written report on the results of such tests shall be submitted to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. Contractor shall verify, in writing, to Engineer or Owner that Contractor has successfully completed the external connection check before beginning system startup or field acceptance testing.

3.2.09 Start Up Assistance. After the field supervisor has completed the system check and submitted his report, Contractor shall supply a factory-trained engineer and a programmer to provide on site start up assistance for the number of days as required. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components.

3.3 TESTING. The system shall be acceptance tested at the factory and on site.

Contractor shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by Contractor and witnessed by Owner and/or Engineer.

Contractor shall notify Engineer and Owner in writing at least 14 days before the proposed testing date. If the factory acceptance test is concluded unsuccessfully, the test shall be repeated. Contractor shall reimburse Owner and Engineer for all expenses incurred in connection with attending repeated factory or on-site testing necessitated by system failure or inadequate preparation.

3.3.01 Factory Acceptance Testing. After system assembly and debugging at Contractor's facility, the system shall be tested before the system is shipped to the project site. When required, the factory test shall be conducted on the complete system, including all field I/O devices, communications equipment, and peripherals;

or when required, using at least the minimum system consisting of computer hardware, software, printer, and one field I/O device.

The entire system, including all peripherals and associated software, shall be factory tested under simulated operating conditions. Both normal operating sequences and fault conditions shall be simulated. The results shall be noted on the CRT displays and the logging printer for hard copy. The testing procedures for hardware and software are described below.

All basic functions shall be demonstrated, including I/O processing, communications, alarm handling, HMI display functions, alarm logging, report generation, and historical data storage, as well as the specific functions listed herein. The system shall operate continuously for at least a 72 hours without faults. This operational test may run concurrently with the demonstration of hardware and software functions. The test procedure shall also include at a least four-hour period for discretionary tests to be conducted by Engineer or Owner.

For systems with software configuration by Engineer/Owner, a preliminary version of such configured software may be used as part of the factory acceptance test.

3.3.02 Hardware Test. Processors, processor modules, and peripheral devices associated with the system shall be assembled together as they will be installed in the field and shall be tested. The test shall demonstrate proper operation of each hardware device and communications among devices, and shall include verification of selected analog and discrete inputs and outputs.

3.3.03 Software Test. All system software modules specified herein shall be demonstrated. Software tests shall include running all diagnostics, debugging routines, and system test routines. The operating system, advanced process control language compiler, and all associated drivers shall be fully tested and operable for the system test. Software "patches" or changes to bypass failed or flawed modules during the test will not be acceptable.

3.3.04 Site Acceptance Testing. After installation and checkout by Contractor's personnel, the system shall be subjected to an acceptance test.

Site acceptance testing shall be scheduled after receipt of the System Check Out Report and Contractor shall verify that all field signal changes are reflected in the proper address locations in the system database.

The site acceptance testing shall follow the same procedure as the factory testing and shall operate without loss of basic functions. The number of days of continuous operation required for the test shall be as required. The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by Contractor's field representative. Contractor's field representative need not be continuously present during the site acceptance testing, but shall be available to respond to the site within one hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

3.3.05 Failure of Redundant Equipment. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Engineer, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

3.3.06 Completion of Test. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the Supplementary Conditions.

3.4 TRAINING. Contractor shall conduct training courses for personnel selected by Owner. Seven categories of training, instrument, control system maintenance, operator (pre-installation), operator (post-installation), programmer (HMI software), programmer (PLC software), and supplemental shall be provided as required. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.

3.4.01 General Training Requirements. In general, Contractor's standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed. Clock hour requirements for each level of training are as indicated in the Contract Documents. A "clock hour" is defined as one hour of instruction or supervised training exercise. Minimum requirements listed for each training category shall be as required. Training hour requirements noted in the data sheet are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.

3.4.02 Training Costs. All costs associated with the training program; excluding travel, lodging, and per diem expenses for Owner's and Engineer's personnel to attend off-site training programs; shall be the responsibility of Contractor and shall be included in the contract price.

3.4.03 Lessons. Training lesson plans and other information for the second stage submittal as defined herein shall be submitted at least 30 days prior to the start of training.

3.4.04 <u>Video Taping</u>. When required by the Contract Documents, all training sessions shall be videotaped for Owner's future use in training other personnel. Videotapes of Contractor's standard training programs may be substituted if they cover the same topics and are developed for the same versions of hardware and software. Furnishing videotapes of standard training programs shall not relieve Contractor from any of the training requirements specified herein. Videotapes shall be 1/2 inch VHS standard.

3.4.05 <u>Instrument Training</u>. Training on the calibration, maintenance, troubleshooting, and repair for the instrument devices provided under this project shall be provided. Training shall be conducted at the Contractor's or Owner's facilities as required. Training shall also be provided for any hand-held or computer-based calibration devices and their associated software.

3.4.06 <u>Control System Maintenance Training</u>. System maintenance training shall be provided to enable Owner's personnel to perform routine and preventive maintenance, troubleshoot, and repair all hardware furnished with the system, except equipment provided by the HMI computer manufacturer. Maintenance and repair instruction shall assume that Owner's personnel will repair equipment by replacing circuit boards and modules, and shall not include instruction on circuit board level repair.

3.4.07 <u>Classes</u>. All maintenance training shall be conducted at Owner's facilities. Each training session shall consist of the number of hours and for the number of Owner's personnel as required.

3.4.08 <u>Content of Classes</u>. The training shall cover at least the following topics:

Preventive, scheduled maintenance for all equipment.

Function and normal operation of circuit boards and modules.

Diagnosis of hardware failures to the faulted board or module.

Removal and replacement of removable circuit boards and modules.

Emergency maintenance and restoration procedures.

The maintenance-training program shall be developed for personnel who have experience in electronics maintenance and repair and a general knowledge of computer systems, but not necessarily any familiarity with the specific hardware furnished.

3.4.09 <u>Operator Training</u>. Owner's operators will utilize the system for day-to-day monitoring and/or control of the facilities. The training program shall provide operators with sufficient knowledge to move from screen to screen within the system, understand the contents of group and detailed point displays, react to and acknowledge alarms, adjust control setpoints and alarm limits, configure and print shift reports, print preconfigured reports on demand, control equipment connected to the system, and react to and resolve minor system errors.

3.4.10 Classes. Operator training may include both pre-installation and post-installation sessions as required.

3.4.11 Pre-installation Session. Each pre-installation training session shall consist of the number of hours and for the number of Owner's personnel as required.

3.4.12 Post-installation Session. The post-installation training shall include three separate, but identical, sessions for three shifts of personnel and shall be conducted at Owner's facilities. Each class shall consist of the number of hours as required of instruction using the same lesson plan as the pre-installation training. The post-installation sessions may have to be conducted outside normal working hours to accommodate the working schedule of Owner's personnel. The post-installation training sessions shall be conducted for the number of Owner's operating personnel as required.

3.4.13 Content of Classes. Each session shall cover at least the following topics.

Power-up, "bootstrapping", and shutdown of all hardware devices.

Logging on and off the system and the use of passwords.

Access and interpretation of standard displays and diagnostics.

Use and care of operator workstations, servers, video displays, printers, and other control room hardware, including replenishment of supplies and replacement of ribbons and ink cartridges.

Moving from screen to screen within the graphic display environment.

Interpretation of preconfigured group and detailed point or database displays.

Response to and acknowledgment of alarms.

Adjustment of control set points and alarm limits.

Configuration and printing of shift and other reports by schedule or on demand.

Control of field equipment and devices connected to the system.

Manual entries to database points.

Generation of current (real-time) and historical custom and predefined reports and trend displays.

Appropriate responses to software and hardware errors.

Enabling and disabling individual inputs and outputs.

The operator-training program shall be developed for personnel with no prior computer experience.

3.4.14 Programmer Training (HMI Software). The programmer training shall be furnished as described in this section.

System programming training shall be provided to enable Owner's and Engineer's personnel to initially configure and later reconfigure the system. Programming tasks shall include addition or modification to the system database; modification or creation of graphic and tabular display and report formats; and creation and modification of historical archiving groups and data reduction algorithms.

3.4.15 Classes. Programmer training shall be conducted in two sessions. The first session shall consist of the number of hours as required of instruction for the number of programmers as required and shall be conducted at Owner's or Engineer's facilities within 30 days of delivery of the configuration hardware and software. The second session shall consist of the number of hours as required of instruction for the number of programmers as required and shall be conducted at Owner's facility.

3.4.16 Content of Classes. Programmer training shall include, but shall not be limited to the following topics:

Loading of any required software into the system.

Use of basic operating system commands for file management, system startup, and creation and editing of batch files.

Creation and editing of database.

Configuration of printed report formats.

Creation and editing of tabular and graphic HMI interface display screens.

Diagnostic routines.

Creation and modification of control algorithms.

Addition of new I/O points and new RTUs, PLCs or DCUs to the system.

Historical record retrieval, data reduction, archiving, and disk housekeeping.

System backup procedures and reloading from backup.

Programmer training shall be designed for personnel who have a general familiarity with computer control system operation and high-level application programs, but not necessarily with the specific hardware or software furnished for this project.

3.4.17 Hardware and Software. The first session of training shall be conducted using hardware and software of the same versions as provided for the system specified. Programmer training for the second session shall be conducted using equipment and software installed at the site.

3.4.18 Programmer Training (PLC Software). Programmer training shall be provided for the PLC software furnished. Programmer training shall minimally be provided on the following topics.

File management and backup procedures.

Documentation printing options.

Entering I/O and database points.

Logic function programming.

PID loop programming and tuning.

Error recovery and interpretation of errors.

Communication protocol set-up and diagnostics.

PLC software programmer training shall be conducted at Owner's or Engineer's facilities within 30 days of delivery of PLC's. The number of hours as required of instruction for the number of programmers as required shall be provided.

3.4.19 Supplemental Training. When required Contractor shall provide additional training to Owner's personnel on topics of Owner's choosing. Supplemental training shall be conducted in one session at Owner's facilities using the hardware and software installed for this project. The number of hours as required of supplemental instruction shall be provided.

End of Section

SECTION 17200

COMPUTER SYSTEM HARDWARE

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing and installation of standard computer hardware fully configured to work with the software specified in another section. Principal items of the computer and peripheral hardware to be furnished as specified or are indicated on the control system block diagram on the drawings.

Contractor shall furnish all necessary interconnecting cables, accessories, and appurtenances as well as additional computer or peripheral hardware required for proper operation and to meet the functional requirements indicated on the drawings and specified herein.

All equipment shall be capable of tolerating and "riding through" a power interruption of 8 milliseconds or less without interruption of normal operation.

1.1.01 Control System. Master Specification Section 17100, Computer Control System, shall apply to all computer hardware furnished under this section.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, Engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. When required, the General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.3 SUBMITTALS. Submittals shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts and consumable items shall be provided as required.

All consumables and spares shall be supplied by the computer or printer manufacturer or by a vendor expressly recommended by the manufacturer.

Contractor shall replace any consumables or spares that are spent during setup, testing, and commissioning of the system.

PART 2 - PRODUCTS

2.1 SYSTEM COMPUTERS. Contractor shall ensure that all computers are configured to operate properly with all software, input/output devices, and peripherals supplied.

2.1.01 Server Computers. When required each Server Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

Two 8 GB SCSI Wide Ultra 2/3 hard drives with integrated RAID controller

Single CPU (with dual CPU capabilities)

32X CD-ROM

Integrated VGA compatible video controller

256 kB Cache

Six hot-pluggable hard drive bays

Standard 3.5 inch (8.9 cm) 1.44 MB diskette drive

Redundant power supplies

One or two 10/100 Mbps RJ-45 connectivity ethernet cards as required

19 inch rack mount or tower enclosure as required

Mouse

Standard Windows keyboard

2 Serial Ports standard

1 Parallel Ports standard

Monitor as required

2.1.02 Magnetic Storage Device. One 120 MB, 3.5 inch, or one 250 MB, Iomega Zip fixed-mounted floppy drive shall be supplied and mounted in the computer enclosure as required. The floppy drives shall be manufactured by Imation, Panasonic, or equal. An internal IDE floppy drive controller shall be supplied to control the drive.

2.1.03 Removable Hard Drive. When required a removable hard drive shall be capable of storing a minimum of 2 GB of data on a removable cartridge. The drive shall be internally or externally mounted as required. The drive shall be Iomega Jaz, Castlewood Orb, or equal.

2.1.04 DLT Tape. When required a Digital Linear Tape (DLT) drive shall provide at least 20 GB of uncompressed data storage per single cartridge. The tape drive shall be supplied with spare tapes as required. The drive shall be HP SureStore, Quantum, Compaq or equal,

2.1.05 CD-RW Drive. When required a CD-RW (read/write) drives shall be capable of meeting the latest Phillips and Sony's recordable CD standard, also known as the Orange Book standard for CD/RW with a minimum of 8x read and 4x record. CD drive shall be manufactured by HP, Sony, Panasonic or equal. CD drives shall be supplied with spare disks as required.

2.1.06 Serial Communications Port Expander. When required, one 8-port RS232 board shall be supplied, installed in the host computer, and configured to allow communications between the computer and all peripheral serial devices. The communications board shall be a Digi International "DigiBoard PC/8e." An 8-port, male DTE, DB25 I/O cable shall be supplied to connect the DigiBoard to all peripheral serial devices specified and shown on the drawings.

2.1.07 Modem. When required, an internal fax-modem, rated 33.6kBPS or 56kBPS, shall be supplied with the computer. The fax-modem shall support ITU-T V.17, V.29, V.27, ITU Group III standards for fax transmissions and ITU-T V.34, V.32bis, Bell 212 and 103 standards for data transmissions. A 56kBPS modem shall also support V.90 standards. The fax-modem shall be US Robotics or equal.

2.1.08 Workstation Computers. When required by the Contract Documents each Workstation Computer shall be comprised of the following configuration. This configuration is to be provided as a minimum:

2 GB hard drive

Single CPU

40X CD-ROM

16 MB AGP video card

256 kB Cache

Standard 3.5” 1.44 MB diskette drive

One 10/100 Mbps RJ-45 connectivity ethernet cards as required

3 button Intellimouse

Standard Windows keyboard

2 Serial Ports standard

1 Parallel Ports standard

Sound Card and speakers

Monitor as required

2.1.09 Magnetic Storage Device. One 120 MB, 3.5 inch (8.9 cm), or one 250 MB, Iomega Zip fixed-mounted floppy drive shall be supplied and mounted in the computer enclosure as required. The floppy drives shall be manufactured by Imation, Panasonic, or equal. An internal IDE floppy drive controller shall be supplied to control the drive.

2.1.10 CD-RW Drive. When required a CD-RW (read/write) drives shall be capable of Orange Book standard with a minimum of 8x read and 4x record. CD drive shall be manufactured by HP, Sony, Panasonic or equal. CD drives shall be supplied with spare disks as required.

2.1.11 Notebook Computer. When required a notebook computer shall be provided. The notebook computer shall be configured as a minimum of a Pentium III processor with a 14.1” TFT display, 256Mb of RAM, one 10GB EIDE hard drive, 24X CD-ROM, video controller with 8 MB of memory, standard 3.5 inch (8.9 cm) 1.44 MB diskette drive, and ethernet card that supports 10/100 Mbps RJ-45 connectivity, integrated sound, and V.90/K56 modem. The notebook computer shall be provided with a lithium/metal-halide battery to provide a minimum of three hours of use. The notebook computer shall be a Dell Latitude, Hewlett Packard Omnibook, Toshiba Tecra, Compaq Armanda, or equal.

When required each notebook computer will be provided with a docking station with the following features:

Integral 10/100 Base-TX ethernet connection

Two (2) 3.3V and 5V PCI expansion slots

Monitor and monitor stand as required by the Contract Documents

Locking mechanism

Standard I/O ports – serial, parallel, video, mouse, keyboard, USB

Standard Windows keyboard

Two/Three button Intellimouse

2.2 SYSTEM PRINTERS. When required, a dot matrix printer shall be supplied for logging system alarms and events, a laser printer shall be supplied for generating system reports, and a color graphics printer shall be supplied for producing color plots of process graphic screens, trends, and charts.

2.2.01 Alarms and Events Printers. Each alarms or events printer shall be 24-pin impact dot matrix type designed for use in 100 percent duty-cycle applications and shall have tractor feed mechanisms suitable for continuous forms up to 14-7/8 inches (37.8 cm) wide.

Printers requiring thermally sensitive, chemically treated, or other special paper will not be acceptable. The alarms printer shall meet the following minimum requirements:

The printer shall contain an 8 kilobyte internal print buffer.

The printer shall support the standard ASCII character set.

The printer shall be capable of printing 200 characters per second in draft mode and 65 characters per second in near-letter quality mode.

The printer shall contain a serial interface card with an internal print buffer.

The printer shall be an Epson "LQ2180" or equal.

2.2.02 Report Printer. The report printer shall be laser type, capable of printing on letter or legal sized sheets of standard paper. The printer shall accept paper fed manually or from one of two paper trays, each with a minimum capacity of 200 sheets.

The report printer shall print at least 10 pages of text per minute at a resolution of 1200 dpi or greater. The printer shall contain a minimum of 8 MB of on-board RAM, expandable to 40 MB. The report printer shall be a Hewlett Packard LaserJet 2100 series or equal.

When required the color graphics printer must be provided with a 10/100Base-TX interface to provide connectivity to the computers over the ethernet network.

The reports printer shall be supplied with at least three spare toner kits and 3,000 sheets of paper.

2.2.03 Color Graphics Printer. The color graphics printer shall be of color inkjet type, shall not require the use of thermally sensitive, chemically treated, or other special paper, and shall meet at least the following minimum requirements:

> Shall be capable of delivering 1.5 pages per minute at the best color quality print speed.
>
> Shall utilize at least four separate color print heads for accurate color reproduction.
>
> Shall have a print quality of 1200 x 600 dpi in the color print mode.

The color graphics printer shall be a Hewlett Packard HP Business Inkjet 2200/2250 Series or equal.

When required the color graphics printer must be provided with a 10/100Base-TX interface to provide connectivity to the computers over the ethernet network.

2.3 NETWORK HARDWARE. Network hardware shall be furnished when required.

2.3.01 Ethernet Switches. When required the ethernet switch shall provide isolation between the various segments of the network to minimize traffic and to prevent failure of one segment from disrupting the entire network. Each switch shall have UTP (Ethernet) ports with RJ-45 connectors. Each switch connection shall automatically sense the network speed of the devices to which it is connected. Switches shall be Cisco “Catalyst Series”, Hewlett Packard “Procurve Switch” series, 3Com “SuperStack II” series, or equal. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

2.3.02 Network Routers. When required routers shall be provided to allow connection of a Wide Area Network (WAN) to Local Area Networks (LAN). These routers must provide the flexibility to adapt to changing requirements, features and performance to support new WAN services, and integration of multiple network functions to simplify deployment and management operations. These routers shall be manufactured by Cisco 1700 series Modular Access Routers, Hewlett Packard ProCurve Routing Switches, 3Com “SuperStack II” series or equal.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS. Installation, field check, testing and training shall be as described in Master Specification Section 17100, Computer Control System.

End of Section

SECTION 17250

COMPUTER SYSTEM SOFTWARE

PART 1 - GENERAL

1.1 SCOPE. This section covers computer software to be furnished and installed by Contractor on computer hardware specified in another section.

Contractor shall furnish standard, field proven, fully developed and supported software packages for this application with a minimum of additions or changes. The number of input/output points should be 50% beyond the number required or the maximum available, whichever is lesser. Customized or specially written software shall be furnished only if required to meet all functional requirements specified herein.

Software is described in functional categories. Contractor shall furnish a complete software package including the functional requirements specified, along with any additional software required for proper and efficient operation of the system.

No attempt has been made to list all software or all characteristics of software required by Contractor to meet the functional requirements specified, nor to determine the location of the software modules within the system.

The computer control software shall meet the design conditions and performance as required.

1.1.01 Control System. Master Specification Section 17100, Computer Control System, shall apply to all software furnished under this section. Additional software requirements indicated in Master Specification Section 13500, Information Data Centers shall also apply.

1.2 GENERAL. Software packages shall control computer system level activities as well as higher level process control activities, allowing the process to be monitored and controlled through an interactive operator interface.

1.2.01 Interface. Users shall be able to interface to all process control activities through fully interactive software modules initiated and operated using easily recognized icons or custom symbols or driven by full-screen and pull-down menus. Selection of icons or menus shall be through pointing devices and shall not normally require the use of an alphanumeric keyboard. Systems that require the use of typed commands to move from module to module or from display to display are not acceptable.

1.2.02 Execution. Throughout the execution of all software modules, the operator shall be presented with all command or operation choices available at that point in the program to make the choices self-explanatory and unambiguous. Question-and-answer or fill-in-the-blank requests are acceptable only where file names, tag names, or other unique text or numerical information is required.

1.2.03 Configuration. All programs shall be self-configuring to obtain the size and configuration of the system from parameters contained in the various files created during system generation. No parameters related to the hardware configuration shall be hard coded into any of the software.

1.2.04 Version. All programs shall be the latest version commercially available at the time the system is delivered to Owner. Superseded versions, revisions, or releases are not acceptable.

1.2.05 Y2K Compliance. All software shall be year 2000 compliant.

1.2.06 General Equipment Requirements. When required, the General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.07 Drawings. Supplementing this section, the drawings indicate locations and arrangement of computer enclosures and provide one-line and block diagrams regarding the connection and interaction with other equipment.

1.3 SUBMITTALS. In addition to the requirements of Master Specification Section 13500, Information Data Centers, a complete description of the software packages and modules shall be submitted to verify compliance with this section. Submittals shall be submitted in accordance with Master Specification Section 01080, Project Submittals

1.4 DELIVERY AND SHIPPING. Delivery and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 OPERATING SYSTEM SOFTWARE. Operating system software shall be as required and shall include a complete and unmodified operating system that provides system level functions. A Graphical User Interface (GUI) shall also be provided to enhance the usability of the operating system.

2.2 PROCESS CONTROL SYSTEM APPLICATION SOFTWARE. Process control software shall be as required and shall enable the operator to monitor and control field devices connected to PLCs, RTUs, or other input/output hardware. The process control system application software shall meet the following minimum requirements and shall exceed these requirements where necessary to comply with the functional requirements of the project.

A license shall be issued for each machine loaded with process control software.

2.2.01 Approved Software. The process control system application software shall be as required. The control system hardware is specified in Master Specification Section 17200, Computer System Hardware.

When required, a dual network shall be provided to insure LAN redundancy.

2.2.02 Password Protection. Operator access within the control system software shall be controllable through a password-based security scheme. Each operator shall be assigned their own user account and password. A number of levels of security protection shall be provided as required by the Contract Document. Each system display, database block, control action, and software module shall be assigned its own security levels and shall be inaccessible to users without proper security clearance. After initial creation, passwords shall be field alterable, but only by the assigned user or a system administrator.

2.2.03 System Response. All responses to the operator shall be clear, unambiguous, and complete. Every operator menu, target selection, or request shall generate a response providing the range of choices for the next step in the process, or indicating that the request or chosen operation has been completed, is being processed, or cannot be performed. Every operator menu or target pick shall generate a graphic or text message response, even if it is a negative one.

2.2.04 Interactive Software Commands. The software's interactive command structures, user interface, menu organization, and procedures shall be consistent and predictable for all software modules throughout the system. Similar operations shall be performed in a similar manner, so that an operator will not need to learn different techniques for initiating the same operation in different software modules.

2.2.05 Operator Commands. The software shall accept each operator command or selection, decode it, and check its validity and correctness in the sequence of data and operations previously presented. Invalid or incorrect commands or menu selections shall not be processed; instead, a message shall be generated which explains why the command or menu selection is invalid. When a command or selection is canceled prior to being fully processed, the software shall clear all pending sequences and shall not initiate any system control commands.

2.2.06 Database. The software shall include a comprehensive interactive database system for creating, sorting, editing, and monitoring all process inputs and outputs and internally used variables and control blocks. The system shall request, receive, process, and store all real-time data according to the information contained in the database. Database points shall be enabled or disabled individually at any time by an operator working at the proper security level. When required, all internal database point information shall be accessible to other external database software applications through an SQL-compliant interface.

2.2.07 Interactive Database Editor. An interactive database editor software module shall be provided for creation, inspection, and modification of database entries. Modification, addition, or deletion of database information shall not require direct changes to the program source code. Changes made in the database contents or formatting shall automatically update all locations at which the information is stored or used.

2.2.08 Custom Algorithms. The software shall enable the users to create their own custom algorithms or command sequences through accessing database points, internal pseudo-point variables, math and logic comparisons, and standard system functions. Each algorithm and command sequence shall run independently and shall be configurable to be executed on demand, based upon an event or condition, on a timed-interval, or at a set time of day.

2.2.09 Programming Language. A programming-type language or environment shall be considered acceptable if it is integrated into the base control system software product; if any compilers, linkers, and other necessary software modules are either included with the base software or supplied and configured by Contractor; if technical support is provided directly by the control software vendor; and if all control system database points and variables are accessible to the programmer.

2.2.10 Alarm Processing. Alarm processing software shall be provided to recognize and report alarms to the operator in an organized, unambiguous, clear, and convenient manner. Alarms shall be classified into at least five priority levels and at least two independent classes. System events shall be considered alarms classified by their own specific priority or class.

2.2.11 Alarms. Alarm processing software shall generate alarms for at least the following conditions.

> Discrete input or output change of state if defined as an alarm in the database.
>
> Analog value exceeding the alarm limits defined in the database.
>
> Analog rate of change exceeding the limits defined in the database.
>
> Failure of any process input/output hardware, communications link, or other major hardware component.

2.2.12 Acknowledgment. Alarms shall be generated as they occur and shall not be cleared until they have been acknowledged and conditions have returned to normal. When required, an alarm shall not clear from a specific operator workstation until it has been acknowledged from that workstation, regardless of whether it has been acknowledged at other workstations in the system.

2.2.13 Alarm Summary Display. An alarm summary display shall be provided which lists at least 100 of the most recent alarms in all classes, with the most recent alarm listed first. Alarms shall appear flashing or in a unique color until they are acknowledged by the operator. Alarms of different priorities shall be easily distinguished on all alarm displays through the use of unique colors or similar methods.

When required, each operator workstation in the system shall be configured to display only certain alarms, alarm classes, and alarm priorities based on the preferences of Owner and Engineer.

2.2.14 Alarm Logging. Alarm logs shall constitute a hard-copy record of all alarms, events, and significant operator actions. Alarm displays and alarm log entries shall include the date and time that the alarm was detected, the tag name and description of the alarmed point, and an entry describing the nature of the alarm. Alarms shall be logged on an alarm and event printer as they occur.

2.2.15 Responses to Alarms. An audible alarm shall sound at the operator's console at each occurrence of a new alarm event. The audible alarm shall be silenced when it is acknowledged by the operator.

When required, voice annunciation shall be used to annunciate alarm events.

The audible alarm shall use an external sound system, such as a sound card and external speakers.

2.2.16 Alarm Enabling. Alarms originating from database entries such as discrete change of state or analog limit violations shall be enabled or disabled on a point-by-point basis.

2.2.17 Alarm Processing Software. An external alarm processing software package shall be provided to generate alarms for a paging system. Two licensed copies of the software shall be provided. The software shall be Win911 or SCADAlarm, or equal,

2.2.18 Operator Interface. System software shall be suitable for creation and modification of alphanumeric and graphic displays and linking of dynamic fields to database variables.

2.2.19 System Storage. The system shall be capable of storing and utilizing full-screen user displays and pop-up windows, as required, each containing any number of the following components.

Static and dynamic alphanumeric information.

Static and dynamic or object-based graphics.

Dynamic bar graph displays.

Dynamic analog real-time and historical trends displays.

Static and dynamic bitmap (Windows .BMP compatible) graphics.

2.2.20 Component and Configuration Information. The software shall enable the user to reuse components and configuration information from any screen or pop-up window with or without modification. All configuration information shall be displayed in any of 256 colors, flashing or non-flashing. Dynamic fields shall change color or from flashing to non-flashing and back in response to a change in value, state, or alarm condition of the linked variable. Dynamic objects linked to process inputs and outputs shall be capable of displaying at least three equipment states, such as on/off/alarm for pumps, or open/close/intermediate for valves.

2.2.21 Communications. System software shall support communications among computers and PLCs as indicated on the drawings and as specified herein. Contractor shall be responsible for any device driver development required to support the communications indicated.

2.2.22 Data Retrieval and Transmission. The software shall retrieve and send data from and to all remote field devices indicated on the drawings. The software shall perform all required error checking to ensure the validity of all data transactions and proper completion of the scan sequence. All communication system malfunctions, including "no response", shall be reported to the system as alarms. Re-transmission shall be utilized to correct or overcome communication errors.

2.2.23 Communications Driver. The software shall be supplied with communications drivers capable of communicating with any existing remote field devices indicated on the drawings as well as all software input/output drivers required to communicate with all field devices and system hardware that are furnished as part of the control system.

2.2.24 Reports. Report logs shall constitute a hard-copy summary of user-selected process data. At least 30 report formats shall be available in the system. Report printing software shall include a user-interactive, on-line report editor to allow the operator to select the following parameters for each report.

Data consisting of measured variables, calculated variables, and manually entered data.

Starting and ending time of data to be included in the report.

Print format for each variable.

Titles and subtitles to appear on each page of the report, including report name, current time, and date.

Paper width (from 8 to 14 inches).

Print pitch (from 5 to 16.5 characters per inch).

Number of columns on each page.

Number of lines per page and number of pages per report.

2.2.25 Database Points. All database points in the system, including all input/output points, manually entered points, and calculated points, shall be available for use in reports. Reports shall include sample, average, minimum, and maximum values for analog variables and the time of occurrence for minimum and maximum values. Information printable for discrete variables shall include running time, state, and transition count.

2.2.26 Report Formats. Report logs shall constitute a file or a hard-copy summary of user-selected process data. All historical data for points in the history database shall be available for reporting from a Structured Query Language (SQL) and Open Data Base Connectivity (ODBC) compliant database. Reporting software shall have the following features.

Creation and modification of report formats or content shall not require direct modification of system source code. Reports shall have the ability to be created in third party software packages such as Microsoft Excel and Microsoft Access.

All database points in the system, including all input/output points, manually entered points, and calculated points, shall be available for use in reports. Reports shall have the ability to include actual value, average, minimum, and maximum values for analog variables and the time of occurrence for minimum and maximum values. Information printable for discrete variables shall include running time, state, and transition count.

2.2.27 Historical Data Storage. The software shall include modules for historical data gathering, data reduction, and reporting. Real-time analog signal values shall be collected and stored in the historical database based on a user defined time interval of 1 second to 1 day, or on a change of state deadband configured for each database point. The historian shall support the following features.

The historical database shall be a real-time relational database. The database shall be an extension of Microsoft SQL Server. The historical database shall acquire point information from the graphical user database.

Access to data shall be by any SQL or ODBC compliant software package, such as Crystal Reports, Oracle database applications, Microsoft Excel, or Microsoft Access.

Database shall allow the use of a separate I/O server for data from the programmable logic controller system.

2.2.28 Data Reduction Capabilities. Data reduction capabilities shall be provided to average and reduce data to hourly records, and the hourly records to daily records. Entries for all hourly and daily averaged records shall include sample, average, minimum and maximum values as defined by Owner. Both hourly and daily averages for each day shall be stored in the historical database.

2.2.29 Retrieval Software. Data retrieval software shall be provided to allow access to historical data files for the following uses:

Tools shall be provided for remote trending and display of the data on all user workstations. Trend displays shall allow up to eight tags to be graphed in the window. Graphs shall allow stacking or separate display of each tag. Displays shall allow save functions for retrieval from the computer hard drive. Trends shall display real-time data, or display data from the history files. The trend display shall show the time frame of stored data.

Import/export of data from/to ASCII files.

Inclusion in user-generated reports.

Tools for Microsoft Excel display of data shall be included. Tools shall allow the retrieval and display of real-time data, or historical data.

2.2.30 Off-line Storage. The software shall include provisions for copying to backup media any or all of the historical data currently stored on the hard drive. The software shall support archival of data to tape and to any other backup devices specified in Master Specification Section 17200, Computer System Hardware. Archival of data shall be intuitive and the archival software shall guide an operator through the backup process.

2.2.31 Backup Data. Once historical data is copied to back-up media, the software shall allow the operator to delete it without negative consequences to free space on the hard drive. Archived historical data shall be re-loadable and usable in all the same ways as historical data that has not been removed from the local hard drive.

2.2.32 Logical Disk Drive. If the backup device is on-line and addressable by a logical disk drive letter (e.g., an optical disk drive defined as "D:"), historical data archived to that device shall be accessible directly without restoration to a local hard drive.

2.2.33 Internet/Intranet Connectivity. When required, the software shall include provisions for making connections to the process data through the existing corporate Intranet or through a connection made on the Internet. This "thin client" solution shall provide authorized users access to all displays and process information by utilizing any standard Internet browser.

The application software shall include software for development for web browser based interface. Features shall include the following:

The software shall allow access to the real-time process operations through any web browser without special software on the computer.

The software shall provide security to prevent unauthorized use.

The software shall allow the user to view alarms through the browser.

The software shall allow the user to view historical data through the browser.

2.3 SOFTWARE DOCUMENTATION. Contractor shall relinquish all documentation supplied with the software furnished, such as user manuals, programmer guides, reference cards or keyboard templates, and related materials. In addition, Contractor shall generate and submit to Owner and Engineer written documentation of any configuration work, modifications of the system, or setup of software done before or after installation of equipment on the site. Documentation shall be electronic or written as required. This includes any and all information on the development of any "wizards" or "scripts" created for the use in this project.

2.4 PLC SOFTWARE. The requirements for PLC software are indicated inthe Contract Documents.

2.5 EXTENDED SUPPORT OR WARRANTY. The process control system software shall include the extended or comprehensive support service of the manufacturer. The service shall include all software updates and phone and personal support when needed. The service shall be for a period of one year after final acceptance and shall cover all software packages supplied under this contract.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS. The Contractor shall install the process control software on the control system hardware specified in Master Specification Section 17200, Computer System Hardware.

3.1.01 Configuration. Contractor shall install and properly configure any supplemental programs, modules, and software packages necessary to meet the functional requirements of the project as indicated in the Contract Documents.

3.1.02 Quantity. The Contractor shall install a full development software package on each control system server and runtime software packages, one on each of the operator workstations as required.

End of Section

SECTION 17300

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SCOPE. This section covers programmable logic controllers (PLCs) as designated and as required, including associated input/output hardware to control process equipment and serve as the interface to field devices.

1.1.01 Control System. Master Specification Section 17100, Computer Control System, shall apply to all equipment furnished under this section. Additional PLC software requirements are indicated in Master Specification Section 17250, Computer System Software.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.02 Drawings. Supplementing this section, the drawings indicate the number and sizes of PLCs, locations of PLCs, and provide diagrams and schematics regarding connection and interaction with other equipment. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the drawings.

1.2.03 I/O List. An input/output (I/O) field device signal listing is included in the Contract Documents.

1.3 SUBMITTALS. Submittals shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare processor modules, spare power supply modules, spare I/O cards, and spare communications modules shall be supplied in the numbers as required. Additional spare parts shall be provided as required.

PART 2 - PRODUCTS

2.1 GENERAL. All equipment furnished under this section shall be expressly selected by Contractor for its superior quality for the intended purpose and shall comply with the following requirements.

2.1.01 Interchangeability. All programmable logic controller systems shall be products of the same manufacturer and of the same series or product line. Processors, local and remote input/output hardware, communications modules, and specialty modules such as coprocessors and ASCII modules shall be interchangeable among all I/O panels and systems. PLC modules and hardware by other manufacturers will be acceptable only if the PLC manufacturer does not offer suitable modules and hardware for the same functions.

2.1.02 Initial, Spare, and Future Memory (RAM). Contractor shall provide adequate memory for the amount of I/O, control algorithms, and communications in the initial system.

Each programmable logic controller shall include provisions for future expansion and shall have 100 percent spare memory capacity and 100 percent spare data capacity installed. The spare memory capacity shall be documented by submitting to Engineer, during factory testing, a statement indicating the amounts of memory of all types being utilized and the total amount available in each system. The statement shall include an estimate of the total program and data memory necessary, including spare memory, based on the I/O hardware for the system, and previous programming experience.

Each programmable logic controller shall have 31 days data retention and downloaded at the end of the end of each period.

2.1.03 Spare I/O. Each PLC input/output enclosure shall be provided with at least 20 percent spare inputs and outputs of each type. Spare I/O shall be installed, wired, and interfaced properly to the terminal strip. The spare I/O shall be in addition to any I/O installed and reserved for future process signals as may be indicated on the I/O list. In addition, each PLC input/output enclosure shall be capable of accommodating 25 percent of additional input/output capacity of each type as originally assembled, without the need for additional expansion racks or PLC power supplies.

2.1.04 Expandability. Each PLC processor and associated I/O shall have a future expandability of at least 50 percent of the provided system or as required, whichever is greater.

2.1.05 Acceptable Manufacturers. The PLCs shall be Modicon, Allen-Bradley, GE Fanuc, or Siemens as required.

2.1.06 Signal Power Supplies. A regulated dc power supply for analog output and for analog input loops shall be provided for each I/O rack when required. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or protected against short-circuiting. Output voltage regulation shall be as required by the instrumentation equipment supplied under another section.

The loop power supply shall be separate from the power supply circuit for the processor and racks.

A separately fused 120 Vac or 24 Vdc power source shall be provided for all digital inputs from field devices as required. Unless otherwise noted, all field devices will be provided with dry contacts that close to provide an input to the PLC.

2.1.07 Appurtenances. The PLC processor and I/O hardware shall be provided as complete systems, as shown on the block diagram drawings. The PLCs shall include all necessary hardware and software for a complete working system. All special rack or panel mounted power supplies, special interconnecting and programming cables, special grounding hardware, or isolation devices shall be furnished as required for proper operation of the equipment. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, intrinsically safe relays and current repeaters, surge suppression devices, and isolation devices shall be furnished and installed as required for proper operation of the equipment.

2.1.08 PLC Arrangement. The PLCs shall be distributed and arranged as indicated in the Contract Documents.

2.1.09 Master Plant Control PLC. A master plant control PLC and enclosure shall be provided. The PLC shall be programmed to accumulate all plant monitoring data from all other PLCs, and will be the primary communications point for data exchange with the SCADA system over the radio communications link.

2.1.10 Each Major Treatment Building. A separate PLC and enclosure, installed and wired under this contract, shall be provided for each major treatment process building.

2.2 LARGE PLC PROCESSOR. The programmable logic controller processor shall be an industrial-type rack-mounted unit that utilizes battery-backed Complementary Metal Oxide Semi-Conductor (CMOS) type or nonvolatile type memory. Battery backed memory shall include integral batteries with sufficient capacity for at least 6 months' memory retention without power to the processing unit. Standby and shelf life of the batteries shall be at least 5 years. PLC unit shall be capable of 31 days of data retention and be downloadable at the end of the period.

The system shall include an Erasable Programmable Read Only Memory (EPROM) card for storage of the user program. The processor shall automatically download the user program from the EPROM upon startup after a power loss. The EPROM shall be programmable by the PLC or PLC software, without the use of external PROM programmable equipment.

2.2.01 Diagnostics. The processor shall utilize self-monitoring diagnostic techniques and shall contain easily visible LED diagnostic indicators for "run" and "halt" conditions as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.

2.2.02 Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional, and after all communications, human machine interface (HMI), and network connections have been made. Removal or disruption of network communications, remote I/O communications, and HMIs to allow for on-line programming and monitoring will not be acceptable. A key switch shall be provided on the processor for selection of the operating mode and as a security measure.

2.2.03 Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units. Each programmable controller shall be furnished complete with communication modules for local and remote input/output hardware communications, communications with other programmable controllers, and communication with host computers as shown on the block diagram.

The unit shall be capable of HART digital communication protocol with the necessary circuitry installed.

2.2.04 Environment. The processor shall be suitable for operation in the environments specified in another section.

2.2.05 Programming. The processor shall be programmable using the International Electrotechnical Commission (IEC 1131) international programming standards and ladder logic programming. IEC 1131 programming shall include the following:

Functional Block Diagram

Sequential Function Chart.

Instruction List.

Structured Text.

Ladder Diagram.

Ladder logic programming shall include a minimum of the following capabilities:

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating point Math and Logical instructions.

PID loop control.

Jumps and Subroutine functions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for discrete and analog value storage.

Remote I/O capability.

Fault-mode subroutine.

2.2.06 Programming Capabilities. The processor shall include the following capabilities for programming, debugging of programs, and troubleshooting.

Off-line programming.

On-line programming.

On-line status of coils and registers.

Input/output forcing.

2.2.07 Hardware Configuration. Processors shall be configured for standard rack mounting. Each programmable logic controller processor shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces as required.

2.2.08 Input/Output Hardware. Input/output hardware shall be entirely contained within the PLC enclosure. Programmable logic controllers having fixed, non-removable input/output hardware will be acceptable if spare and future input and output points described elsewhere in this section are furnished as required. Programmable logic controller systems shall support the following types of input/output modules.

120 volt ac discrete input and output.

4-20 mA dc analog input and output.

24 volt dc discrete input and output.

High speed pulse accumulator input.

Platinum RTD analog input.

Binary-Coded-Decimal (BCD) thumb wheel input.

All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices as required and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet the following requirements.

2.2.09 Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2.2.10 I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Discrete outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate either interposing relays or relay-type discrete output modules in the PLC cabinet.

2.2.11 Discrete Input Modules. Discrete input modules shall sense voltages between 100 and 130 volts ac or 20 and 28 volts dc and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Return voltage may be common to the entire input module. Discrete input modules shall have multiple inputs.

2.2.12 Isolated Discrete Input Modules. Isolated input modules cards shall sense voltages between 100 and 130 volts ac or 20 and 28 volts dc and shall have LED indicators for each point to display the status of the field contact. Each point on the input module shall be capable of being connected to a separate voltage source and return. Discrete input modules shall provide complete electrical isolation between individual inputs. Isolated discrete input modules shall have multiple inputs.

2.2.13 Discrete Output Modules. Discrete output modules shall control voltages from 100 to 130 volts ac or 20 to 28 volts dc and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2 mA. Discrete output modules shall have multiple outputs.

2.2.14 Isolated Discrete Output Modules. Discrete output modules shall control voltages from 100 to 130 volts ac or 20 to 28 volts dc and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2 mA. Discrete output modules shall provide complete electrical isolation between individual output circuits. Isolated discrete output modules shall have multiple outputs.

2.2.15 Relay Discrete Output Modules. Discrete output modules shall have dry contact relay type outputs suitable to control voltages from 24 to 110 volts dc and 24 to 230 volts ac and shall be rated at least 2 amperes. Outputs have LED indicators to display output status. Digital outputs for motor driven equipment shall be powered by the driven equipment. Outputs shall withstand a surge of at least 80 amperes for 15 milliseconds. Relay discrete output modules shall have multiple outputs.

2.2.16 Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog input modules shall have multiple inputs.

2.2.17 Isolated Analog Input Modules. Isolated analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Analog to digital conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog input modules shall have multiple inputs. Each input shall be fully isolated from the other inputs.

2.2.18 Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 12-bit (0-4095 count) resolution. Analog output modules shall have multiple outputs.

2.2.19 Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2.2.20 Interposing Relays. Interposing relays shall be incorporated on all I/O circuits as shown on the PLC input/output listing, or as required by the application to isolate foreign power sources, and where the continuous output rating of the PLC relay discrete, or output module is not sufficient to power the connected device or equipment. Interposing relays shall be provided for any discrete output module output signal that leaves the PLC enclosure. Interposing relays shall be mounted in the PLC enclosure containing the output module that activates the relays.

2.3 MINI PLC PROCESSOR. The programmable logic controller processor shall be an industrial type that utilizes battery-backed CMOS type or nonvolatile type memory. Battery-backed memory shall include integral batteries with sufficient capacity for at least 6 months of memory retention without power to the processing unit. Standby and shelf life of the batteries shall be at least 5 years. Mini PLC unit shall be capable of 31 days of data retention and be downloadable at the end of the period.

2.3.01 Diagnostics. The processor shall utilize self-monitoring diagnostic techniques. Easily visible LEDs shall indicate "run" and "halt" status as well as memory and input/output error conditions. Diagnostic codes shall also be available through the programming device to facilitate troubleshooting.

2.3.02 Programming Port. The processor shall include a programming port that is available for programming and monitoring on-line after the system is fully functional. Removal or disruption of network communications, remote I/O communications, or HMIs to permit programming and monitoring will not be acceptable.

2.3.03 Communications. The processor shall be programmed to operate autonomously, regardless of communications status with other units.

2.3.04 Environment. The processor shall be suitable for operation in the environments specified in another section. A key switch shall be provided on the processor to select the operating mode and as a security measure.

2.3.05 Programming. The processor shall be programmable using conventional relay ladder logic, or as required, and shall include the following functions and features.

Contacts, coils, branching.

Data comparisons.

On-delay and off-delay timers.

Counters with comparators.

Floating Point Math and Logical instructions.

Master control relay.

Transitional or one-shot outputs.

Standard and user-defined data tables for discrete and analog value storage.

2.3.06 Capabilities. The processor shall include the following capabilities for programming, debug of programs, and troubleshooting.

Off-line programming.

On-line status of coils and registers.

Input/output forcing.

2.3.07 Configuration. Processors shall be configured for standard rack mounting and shall be of plug-in printed circuit board construction. Each programmable logic controller shall include integral communications ports for the programming device, remote input/output, HMI device, or remote communications interfaces as required.

Programmable logic controller systems shall support the following types of input/output.

120 volt ac discrete input and output.

24 volt dc discrete input and output.

4-20 mA dc analog input and output.

2.4 Input/Output Hardware. For large rack mounted PLCs, input/output hardware shall be supplied in standard modules of 4, 8, 16, or 32 points each for assembly in local and remote input/output enclosures.

All input/output hardware shall be entirely contained within the PLC enclosure.

Programmable logic controllers having fixed, non-removable input/output hardware may or may not be acceptable as required.

All digital input/output hardware shall include isolation against surges of at least 1500 volts. All output hardware connected to inductive loads shall be supplied with surge suppression devices as required and recommended by the PLC manufacturer to prevent damage to output hardware. Combination input/output modules will be acceptable if they meet all of the requirements in the following subparagraphs.

2.4.01 Wiring Terminals. All input/output modules shall utilize easily removable plug-in or hinged field wiring terminals to allow removal of modules without disconnecting individual wires.

2.4.02 I/O Circuit Power Supply. Outputs for motor driven equipment will typically be powered from the driven equipment. Discrete outputs for miscellaneous equipment shall be powered either from the controlled equipment or the PLC enclosure as indicated on the drawings or as coordinated with the controlled equipment supplier. Outputs that control process equipment specified under other sections or provided under other contracts shall be fully isolated or shall operate relay-type discrete output modules or interposing relays in the PLC cabinet.

2.4.03 Discrete Input Modules. Discrete input modules shall sense voltages between 100 and 130 volts ac or 20 and 28 volts dc as required and shall have LED indicators for each point to display the status of the field contact. Each input module shall be suitable for being connected to a separate voltage source and return. Return voltage may be common to the entire input module.

2.4.04 Isolated Discrete Input Modules. Isolated input module cards shall sense voltages between 100 and 130 volts ac or 20 and 28 volts dc as required and shall have LED indicators for each point to display the status of the field contact. Each point on the input module shall be capable of being connected to a separate voltage source and return. Discrete input modules shall provide complete electrical isolation between individual inputs.

2.4.05 Discrete Output Modules. Discrete output modules shall control voltages from 100 and 130 volts ac or 20 and 28 volts dc as required and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2.0 mA.

2.4.06 Isolated Discrete Output Modules. Discrete output modules shall control voltages from 100 and 130 volts ac or 20 and 28 volts dc as required and shall be rated at least 1 ampere. Outputs shall be individually fused and shall have LED indicators to display output status. Outputs shall withstand a surge of at least 80 amperes for one cycle and shall have an off-state leakage current not to exceed 2 mA. Discrete input modules shall provide complete electrical isolation between individual inputs.

2.4.07 Relay Discrete Output Modules. Discrete output modules shall control voltages from 24 to 110 volts dc and 24 to 230 volts ac and shall be rated at least 2 amperes. Outputs shall be individually fused and shall have LED indicators to display output status. Digital outputs for motor driven equipment shall be powered by the driven equipment. Outputs shall withstand a surge of at least 80 amperes for 15 milliseconds.

2.4.08 Analog Input Modules. Analog input modules shall accept linear 4-20 mA dc signals from field transmitters. Input circuitry shall be floating differential type designed to prevent loop grounding. Analog to digital conversion accuracy shall be at least 12 bit (0-4095 count) resolution.

2.4.09 Analog Output Modules. Analog output modules shall transmit linear 4-20 mA dc signals to field devices. Loop power for all analog outputs shall be provided by regulated power supplies in each input/output enclosure and shall be capable of driving a 0 to 600 ohm load. Digital to analog conversion accuracy shall be at least 12 bit (0-4095 count) resolution.

2.4.10 Panel Terminations. All PLC input/output signals for field connections shall be terminated through panel enclosure terminal strips. Direct connection of field wiring to the I/O module terminals is not acceptable.

2.5 COMMUNICATIONS. Each programmable controller system shall be furnished complete with communication hardware modules for local input/output hardware, remote input/output hardware, other programmable controllers, or for host computers as required.

Communication hardware shall be compatible with the cable, data highway, fiber optic, or radio communication media as required.

2.5.01 Addressability. Each programmable logic controller shall be individually addressable so that only the selected controller responds when queried. At least 30, or a larger number as required, distinct network addresses shall be available. Designation of a controller's network address may be either a software or hardware function.

2.5.02 Communications Hardware. Contractor shall provide all necessary communications hardware. Hardware shall be included for, but not be limited to, remote I/O, data highway, host computer, fiber optics, Ethernet and radio.

2.5.03 PLC to PLC Communications Hardware. Each PLC shall communicate to other PLCs over a data highway communications network. Contractor shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2.5.04 PLC to Remote Communications Hardware. The master PLC shall communicate with the remote PLC rack over a remote I/O communications network. Contractor shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system.

2.5.05 PLC to Host Communications Hardware. Each PLC shall communicate to the host computer over a data highway communications network. Contractor shall include all rack mounted, enclosure mounted, or desktop mounted communications modules required for a complete working system. The computer system hardware is covered in another section.

2.5.06 Fiber Optic Communications Hardware. Contractor shall provide all necessary fiber optics transceivers and modems for the PLC system. Communications hardware shall meet the requirements of the manufacturer of the PLCs.

Fiber optic modems shall meet the following requirements:

Full Duplex four wire.

Point-to-Point configuration.

Data Rate of 19.2 KBS for RS-232.

Data Rate of 5 MBS for RS-422.

LED indicators for power, transmit data, and receive data.

Asynchronous multimode RS-232, RS-422, and RS-485; asynchronous RS-232; or asynchronous RS-422.

2.5.07 Radio Communications Hardware. Each PLC shall communicate over radio equipment. Contractor shall provide all necessary hardware for the PLC to communicate with the radio system modem. Communications hardware shall meet the requirements of the manufacturer of the PLCs. Radio equipment is covered in another section.

2.5.08 Communications Media. Contractor shall provide all necessary cabling for the PLC communications network and PLC remote I/O communications network. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules.

2.5.09 Cable. Contractor shall provide all necessary cabling for the PLC system. Communications cables shall meet the requirements of the manufacturers of the PLCs and communications modules.

2.5.10 Data Highway Plus Cabling. Cable shall be shielded pair suitable for installation in conduit. Cable furnished shall meet the requirements of the PLC manufacturer. Cable shall meet the following requirements.

Twinaxial 20 AWG, tinned copper

Polyethylene insulation, color-coded clear, blue

24 AWG stranded tinned copper drain wire

Overall tinned copper braid shield

Blue PVC jacket

Data highway cable shall be Belden "9463".

2.5.11 Modbus Plus Cabling. Cable shall be shielded pair suitable for installation in conduit. Cable furnished shall meet the requirements of the PLC manufacturer. Cable shall meet the following requirements.

24 AWG, tinned copper, one twisted pair

Polyethylene insulation

Overall aluminum/polyester shield

24 AWG stranded tinned copper drain wire

Overall tinned copper braid shield

PVC jacket

Modbus Plus cable shall be Belden "9841".

2.5.12 Metallic LAN Cable. Cable shall be coaxial or shielded pair suitable for installation in conduit. Cable furnished shall meet the following minimum requirements.

Coaxial

Tinned copper center conductor

Cellular polyethylene dielectric

Duobond II Shield

95 percent tinned copper braid

PVC Jacket

Twisted, Shielded pair (STP)

Category 5

Copper conductors

#24 AWG

Aluminum/polyester shield with drain

300 volt rated

Minimum 0.037 inch PVC jacket

Plenum rated

2.5.13 Fiber Optic Cable. Fiber optic cable shall have a loose tube construction with silicon gel filling. The cable shall have at least three pair of multimode fibers. Spare fibers shall be fitted with connectors. Where patch panels or fiber distribution panels are used, all fibers, including spares, shall be properly terminated in the panel. Fiber diameter shall be coordinated with the transceivers or modems supplied. Cables shall be Seicor, Belden, BICCGeneral, or AMP. Cable connectors shall be ST type.

Exposed fiber optic cable within PLC enclosures shall be a jacketed "zip-cord" with industry standard connectors. Single, unjacketed fibers shall not be used for terminations on PLC equipment. Bulk fibers entering a PLC enclosure shall be terminated in a patch panel. Zip-cords shall be run from the patch panel to the PLC components.

Fiber optic terminations shall be performed by Contractor in accordance with the manufacturer's recommendations.

2.5.14 Fiber Optic Communications Hardware. Contractor shall provide all necessary fiber optics transceivers and modems for the PLC system. Communications hardware shall meet the requirements of the manufacturer of the PLCs.

Fiber optic modems shall meet the following requirements:

Full Duplex four wire.

Point-to-Point configuration.

Asynchronous multimode RS-232, RS-422, and RS-485.

Asynchronous RS-232.

Asynchronous RS-422.

Data Rate of 19.2 KBS for RS-232.

Data Rate of 5 MBS for RS-422.

LED indicators for power, transmit data, and receive data.

2.5.15 Radio Communications Hardware. Contractor shall provide all necessary radio communications for the PLC system. Communications hardware shall meet the requirements of the manufacturer of the PLCs. Radio equipment shall be as specified in Master Specification Section 17350, Multiple Address Radio Equipmentand as shown on the drawings.

2.6 PROGRAMMING DEVICE HARDWARE. The programming device shall be a portable notebook computer as specified in another section. Contractor shall provide two interconnecting cables, each 5 meters long, to connect the computer to the programmable logic controller. The cables shall be shielded data cable and shall be terminated on both ends with the appropriate connectors. Connectors shall be labeled to identify the connected equipment.

2.6.01 Special Devices. Contractor shall provide two sets of any special devices (such as null modems, adapter cards, interface converters, etc.) required to establish an operational programming line between the programmable logic controllers and programming device.

2.7 PROGRAMMING SOFTWARE. Contractor shall furnish two licensed copies of PLC programming software; one copy for Owner and one copy for Engineer; or one licensed copy of the PLC programming software for Owner as required. The software shall be functionally identical and shall be suitable for running on the programming device specified elsewhere. A full legal set of programming software documentation shall accompany each copy of the software. Each copy of the programming software shall include all necessary device drivers and add-on software packages.

2.7.01 Standard Product. The programming software shall be personal computer based and a standard product of the PLC manufacturer, or at Contractor's option and with Owner's approval, field-proven third-party software that is functionally equivalent to the PLC manufacturer's software may be provided. The software shall be RS Logix for A-B, or Concept for Modicon.

2.7.02 PLC Emulation. The programming software shall include a PLC emulation feature that allows the program logic of a single PLC to be tested and debugged entirely in the programming device without the PLC.

2.7.03 Programming Software Features. The programming software shall allow off-line development of all PLC-related programming, including user annotation of the program, and creation and printing of application programs and I/O cross-reference lists. Special programming tasks originally provided by Contractor shall also be included.

On-line features shall include IEC-1311 standars program modification, ladder-logic modification, program language modification, monitoring of real-time ladder-logic execution, monitoring of program execution, monitoring and manipulation of timer and counter preset and present values, monitoring and forcing of physical I/O, and monitoring and manipulation of analog (register) and bit (binary) data table values. PLC and I/O hardware diagnostic and status information shall be accessible using the software in on-line mode.

2.8 SYSTEM ENCLOSURES. Programmable logic controllers and input/output hardware shall be housed in shop-assembled panels as indicated on the drawings and as described in another section.

2.9 SYSTEM ENCLOSURES. Programmable logic controllers and input/output hardware shall be housed in existing panels or panels provided by others.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS. PLC installation requirements are specified in Master Specification Section 13500, Information Data Centers, except as described herein.

Field check, testing, and training shall be as described in Section 13500.

3.2 CONFIGURATION.

3.2.01 PLC Programming and Configuration. Configuration services are specified in Master Specification Section 13500, Information Data Centers.

3.2.02 Communications Configuration. The communications shall be fully configured and installed by Contractor, and shall be operational before application software configuration by others. Communications shall be configured as shown on the block diagram drawing.

3.3 FIBER OPTIC CABLE INSTALLATION AND TESTING. The fiber optic cable shall be installed, terminated, and tested by an experienced fiber optic network installer. Each fiber of each fiber optic cable shall be tested after installation. For each fiber with a length of more than 100 ft, an end-to-end power attenuation (insertion loss) test shall be performed. The attenuation test shall utilize a stabilized optical source and an optical power meter calibrated to the appropriate wavelength (850 or 1300 nm).

For each installed fiber the power attenuation shall not exceed the values recommended by the fiber optic transceiver manufacturer. Any fiber optic cables containing one or more fibers not meeting this performance will not be accepted by the Owner. Cable shall be repaired or replaced. All necessary hardware, test equipment, cables and test meters, required for the testing shall be provided. The results of the fiber optic cable testing shall be documented and submitted to the Owner.

End of Section

SECTION 17350

MULTIPLE ADDRESS RADIO EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of radio communication equipment for a Computer Control system, including equipment that is common to the Computer Control System and the field devices as required. Field devices may be PLCs, RTUs, DCUs, etc. The equipment shall consist of hot-standby polling remote radios, hot-standby repeater radios, hot-standby base radios, and remote radios as indicated on the drawings and as required.

1.1.01 Control System. Master Specification Section 17100, Computer Control System, shall apply to all equipment furnished under this section.

1.2 GENERAL. Equipment furnished and under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

1.2.02 General Equipment Requirements. When required, the General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.03 Drawings. Supplementing this section, the Contract Document drawings show the configuration of the radio system, a location map of the sites, and antennae types with support and cable and mounting details. All hardware, including power supplies, special cables, and other appurtenant equipment, shall be provided to meet the functional requirements described herein and indicated on the drawings.

1.2.04 Accessories. Contractor shall provide all necessary equipment such as channel processors, line buffers, communication couplers, and modems, to transmit commands and receive data via communication channels. Contractor shall also provide all radio transmitters, receivers, antennas, and mounting hardware for a complete operational radio system.

1.3 SUBMITTALS. Submittals shall be submitted in accordance with Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as required.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS. Radios and accessories shall be suitable for installation within the field device enclosures or in their own enclosures designed for the environmental conditions as required.

2.2 COMMUNICATIONS EQUIPMENT. Communication equipment (radio transceiver units) shall be furnished as required.

Units shall conform to the following requirements:

	Polling Remote, Repeater, or Base Unit	Remote Unit
Number of channels (per radio)	1	1
Frequency Selection	928/952 MHz	928/952 MHz
Signal Modulation	FM	FM
Modulation Deviation	±3 kHz	±3 kHz
Antenna Gain (db)	9	9
Antenna Vertical Beamwidth	360 degrees	43 degrees
Type of antenna	Omni	Directional

2.2.01 Acceptable Manufacturers. The radio system equipment shall be point-to-multi point UHF radio equipment manufactured by Microwave Data Systems.

2.3 COMMUNICATIONS CHANNEL. The computer control system shall utilize a frequency modulated radio frequency as its communications medium. System transceivers shall operate on a dedicated channel pair in the 950 MHz band in conformance with FCC Rules and Regulations, Parts 22 and 101. Bandwidth shall be 12.5 kHz.

2.4 RADIO EQUIPMENT. The radio equipment necessary for operation of the SCADA system shall be provided by Contractor. The radio system configuration is shown in the Contract Documents. The configuration shall include hot-standby polling remote radios, hot-standby repeater radios, hot-standby base radios, or a remote transceiver radio as shown on the drawings and as required.

Repeater radios shall have direct VF (voice frequency) input/output to accept signals from local field devices. The base radio, polling remote radio, and repeater radio equipment shall be rated for continuous duty. Contractor shall coordinate the radio equipment with the SCADA system.

2.4.01 Mounting Hardware. Mounting hardware for antennae shall be provided by Contractor, and shall be stainless steel to resist corrosion. Towers or other supporting structures provided by others are described in another section.

2.4.02 Digital Interface. When required for field devices, a digital interface shall conform to EIA RS-232 protocol and shall have the following characteristics.

2.4.03 RTS/CTS. Interface shall support RTS/CTS handshaking. CTS shall be granted within 10 msec after RTS. Bit Error Rate shall be 1 x 10^{-6} or better at -111 dBm, kBPS.

2.4.04 Rate. Data rate as required.

2.4.05 Analog Interface. When required, an analog interface shall have the following characteristics.

2.4.06 Audio. Interface shall be 4 wire, 600 ohms impedance, balanced audio, and shall be compatible with all new or existing field devices and computers specified in other sections.

2.4.07 Level. Input audio level shall be adjustable from -16 to +0 dBm. Output audio level shall be adjustable from -20 to +0 dBm.

2.4.08 RTS/CTS. Interface shall support RTS/CTS handshaking. CTS shall be granted within 20 msec after RTS. Bit Error Rate shall be 1 X 10^{-6} or better at -110 dBm, 1.2 kBPS.

2.4.09 Rate. Data rate shall be as required.

2.4.10 Transmitters. The transmitters shall have the following characteristics:

Modulation type	FM
Spurious and harmonic emissions	-65 dBc
Output power at antenna port, "N" type connector	5 watts
Frequency stability	±0.00015 percent, 1.5 PPM (-30 to

	+60°C)
Bandwidth	12.5 kHz
Modulation deviation	±2.5 kHz
Duty cycle	100%, continuous at 5 watts (-30 to +60°C)
Output impedance	50 ohms

After the transmitter is unkeyed, it shall remain on for another 0 to 64 msec. When the transmitter is keyed on, an interval timer shall start with an adjustable 1 to 30 second range that prevents the transmitter from locking up a channel.

2.4.11 Receivers. The receivers shall have the following characteristics.

Type	Dual conversion superhetrodyne
Frequency stability	±0.00015 percent, 1.5 PPM (-30 to +60°C)
Spurious and image rejection	-85 dB minimum
Bandwidth compatibility	12.5 kHz
IF selectivity at adjacent channel	100 dB minimum
RF input impedance	50 ohms
Intermodulation (EIA) (Digital Interface Only)	-75 dB minimum
Desensitization (EIA) (Digital Interface Only)	-60 dB minimum

2.4.12 Power Requirements. When required, each polling remote radio, base radio, or repeater radio equipment shall be designed for continuous operation using a nominal 120 volt, single-phase power source, and shall be provided with an internal battery and battery charger. Each radio battery shall be sized to fully power the radio equipment for at least 2 hours. Each power supply shall be complete with an On-Off switch, indicating light, and input over current protection.

Reliable communication shall be achieved when the equipment is continuously energized at any voltage level from -15 percent to +12.5 percent of nominal, with ambient temperatures as specified.

2.4.13 Voltage Transients. All polling remote radio and repeater radio equipment shall tolerate and ride through the voltage dips, surges, and momentary transients associated with normal power supplies.

2.4.14 Remote Radio Equipment. The remote transceiver radio equipment shall be designed for continuous operation on a nominal 12 V dc source from the field device source or as shown on the drawings.

2.4.15 Test Points. The base radio, polling remote radio, and repeater radios shall have test points for transmitter power and receive signal level. The remote transceiver radio units shall have test points for the transmitter power output, receive signal level, battery voltage and negative supply voltage.

2.4.16 Radio Alarms and Indications. LED indicators shall be provided for local indication of (base radio, polling remote radio, and repeater radio operations) and faults.

2.4.17 Indicators. The units shall have the following indicating lights:

Power On Unit A - Loss of this light shall indicate unit failure or a significant drop in power output (e.g., 3 dB).

Power On Unit B - Loss of this light shall indicate unit failure or a significant drop in power output (e.g., 3 dB).

Transmit Active Unit A - the unit is transmitting.

Transmit Active Unit B - the unit is transmitting.

Receive Active Unit A - the unit is receiving.

Receive Active Unit B - the unit is receiving.

Receive Signal Level - the receiver signal level is above the 20 dB S/N squelch setting. Loss of this light shall indicate low receive levels or unit failure.

Transmitter A failure.

Transmitter B failure.

Local oscillator A failure.

Local oscillator B failure.

2.4.18 Trouble Indication. The base radio, polling remote radio, and repeater radios shall have a relay contact for remote trouble indication for each unit (A and

B). At the repeater radio sites, the contact outputs shall be wired into the field device located at the site as alarm inputs. At the base radio and polling remote radio sites, the contact outputs shall be available for the Owner's use.

2.4.19 Remote Transceiver Radio Indicators. Analog type remote transceiver units shall have the following local indicating lights.

On - Transmitter on; loss of this light shall indicate unit failure or a significant drop in power output (e.g. 3 dB).

Key Line Active.

Transmitter On.

Squelch Open.

Out of Lock.

Radio Disabled.

Digital type remote transceiver units shall have the following local indicating lights.

Request to Send.

Clear to Send.

Carrier Detect.

Transmit Data.

Receive Data.

2.4.20 Cavity Filter Kit. Each base radio or repeater radio shall have a TX-RX dual vari-notch filter including mounting brackets, cable, and connectors. The filter shall pass the received signal from the SCADA remote radios with a maximum power loss of 1.5 dB. The filter shall attenuate signals noise received from paging transmitters by a minimum of 30 dB. The filter shall be mounted in the base or repeater radio enclosure and shall be factory tuned for the radio frequency of the radio. The filter shall be an MDS Model 032144AO1.

2.5 RADIO SYSTEM DIAGNOSTICS. The radios shall include system diagnostics to permit continuous or scheduled automatic monitoring of key operating parameters and alarm conditions.

2.5.01 Communication. The diagnostic package shall communicate data from all remote transceiver radios in the system to the base radio and polling remote radio via the radio's RF channel.

2.5.02 Radio Diagnostic Software. Diagnostic software capable of operation on MS Windows shall be supplied to enable an IBM compatible personal computer or notebook computer to communicate with the radio via a separate RS-232 diagnostic port. The diagnostic software shall support a minimum of 512 remote transceivers per base radio or polling remote radio. The diagnostic software shall support the data/control functions specified herein and shall be fully loaded and operational on the notebook computer furnished hereunder or in another section as required.

2.5.03 Diagnostic Data. Diagnostic data transmitted over the radio frequency channel must use dual tone multi-frequency encoding to eliminate the possibility of diagnostic information being misinterpreted as data being sent from the SCADA system.

2.5.04 Programming Device Hardware. When required, the programming device shall be a portable notebook computer. Contractor shall provide two interconnecting cables, each 5 meters long, to connect the note book computer to the base, repeater, and polling remote radios. The cables shall be shielded data cable and shall be terminated on both ends with the appropriate connectors. Connectors shall be labeled to identify the connected equipment.

2.5.05 Special Devices. Contractor shall provide two sets of any special devices (such as null modems, adapter cards, interface converters, etc.) required to establish an operational programming line between the radios and programming device.

2.5.06 Base Radio or Polling Remote Radio Diagnostic Data/Control Functions. The following functions shall be monitored by the diagnostic system.

The operation and status of redundant transmitter, receivers, and power supplies; including automatic switch over to standby unit upon failure. All modules must be continuously monitored while on line and in standby states.

Remote switch over to the alternate transmitter or receiver to permit remote troubleshooting of radio hardware and software.

Remote testing of the hot standby switch over logic and alarm reporting logic.

Power supply voltage, current, and transmission of power from redundant power supplies and transmitters.

Received signal strength, frequency offset, and FM deviation levels of redundant base radio, polling remote radio, or a repeater radio.

The radio diagnostics shall permit remote adjustment of key parameters in the remote radio transceivers from a personal computer connected to the base radio or polling remote radio. The parameters shall include transmit power, transmit frequency offset, and transmit modulation deviation.

2.5.07 Control and Display Capability. Radio diagnostic software shall include control and display capability of the remote radio transceiver parameters listed below.

Frequency (remote display and control).

Deviation (remote display and control).

Transmit Power Output (remote display and control).

Receiver Signal Strength (remote display).

Power Supply Voltage (remote display).

Internal Voltage Regulator Voltage (remote display).

Phase Lock Loop Voltage (remote display).

Internal Radio Temperature (remote display).

2.5.08 Remote Transceiver Radio Diagnostic Data/Control Functions. The remote transceiver radio shall monitor its internal operation and diagnostic parameters from a hand held terminal or personal computer plugged into the remote transceiver. A loop-back decoder board that operates in conjunction with the base radio or polling remote radio microprocessor to provide signal strength, frequency error, and deviation levels shall be supplied for each remote transceiver radio. The following data/diagnostic functions shall be supplied.

Transmit and Receive Frequencies (display and control).

Time-out Timer Setting (display and control).

Soft-Carrier De-key Setting (display and control).

Loop-Back Code (display and control).

Squelch Tail Eliminator (display and control).

Push-To-Talk Delay (display and control).

Clear-To-Send Delay (display and control).

Frequency (Remote display and control).

Deviation (Remote display and control).

Transmit Power Output (display and control).

Receiver Signal Strength (display).

Power Supply Voltage (display).

Internal Voltage Regulator Voltage (display).

Phase Lock Loop Voltage (display).

Internal Radio Temperature (display).

2.5.09 Remote Transceiver Hand-Held Programmer/Test Set. A Microwave Data Systems hand-held compact programming terminal shall be provided for local programming/testing of all remote transceivers as required. The programming terminal shall provide access to the internal diagnostic and control capabilities of the transceivers and shall be capable of performing the diagnostic and control functions described in this section, including frequency programming and key voltage measurements. The hand-held terminal shall include an interface cable that plugs into the transceiver's external interface connector.

2.6 SURGE SUPPRESSION. Contractor shall provide an in-line surge suppressor on antenna cables at each radio site to protect the radio equipment from damage by lighting. Surge suppressors shall be Polyphaser Series IS-B50LN-C2 or equal.

Two lengths of superflexible Heliax cable shall be supplied for each surge suppressor; one for the connection between surge suppressor and radio antenna port, and one for the connection between the coaxial transmission cable (1/2 inch and larger) and the antenna. The cable shall be terminated with standard N type connectors. The cable shall be Andrew Superflexible Heliax 1/4 inch Type FSS1-50A.

2.7 ANTENNAS. Contractor shall furnish antennas and supporting structures at radio sites as indicated on the drawings.

2.7.01 Omnidirectional Antennas. A 9 dB omnidirectional, full-wave, dipole collinear type antenna with all required mounting hardware, preferably by the antenna manufacturer, shall be provided for each base radio and repeater radio as indicated on the drawings. Radiating elements shall be enclosed in a single length of fiberglass tubing and a brass tube extending from top to bottom, with grounding lug, for lightning protection. A drain plug shall be provided at the bottom of the tube for draining moisture. The antenna shall be mounted as indicated on the drawings. Omnidirectional antennas shall be Decibel DB809 or equal.

2.7.02 Directional Antennas. A 9 dB directional Yagi antenna with a minimum 20 dB front-to-back ratio shall be provided for each remote transceiver radio site and polling remote radio site as indicated on the drawings. Each antenna shall be of heavy-duty design for permanent installation, with gold anodized aluminum support boom and elements and mounting hardware supplied by the antenna manufacturer. The radiating element of the antenna shall be radome protected. Directional Yagi antennas shall be Decibel DB498 or equal.

2.7.03 Wooden Poles. Wooden poles for mounting antennas shall be furnished in the lengths indicated at the locations as indicated in the Contract Documents. The wooden poles shall be burn-branded on the face and the butt. The markings on the face shall be 6 feet (1.8 m) above ground line, assuming standard setting depths. The markings shall be as designated in ANSI 05.1, Paragraph 6.25. Each pole shall have a 15 degree one-way roof.

The poles shall meet the applicable requirements of ANSI 05.1 and AWPA C4.

2.7.04 Radio Towers. Radio towers and foundations shall be furnished in the dimensions indicated at the locations indicated on the drawings. The towers shall meet the applicable standards of AISC, AISI, AWS, EIA and FAA. The towers shall be Rohn BX series and shall be mounted on pre-engineered Rohn recommended foundations for concrete base stubs.

2.7.05 Radio Masts. Self-supporting radio masts shall be furnished of the height at the location indicated on the drawings. The mast shall be of tapered, tubular design, manufactured of high-strength steel, with a galvanized protective coating, grounded to earth, and shall be mounted on a heavy- duty foundation designed and approved by the mast manufacturer. The mast shall be designed for the loading indicated on the drawings and shall be Valmont Industries Model RT, or approved equal.

2.7.06 Grounding Conductors. All ground conductors shall be soft drawn copper cable or bar, not smaller than 12 AWG, bare or green insulated in accordance with the National Electrical Code.

2.7.07 Ground Rods. Ground rods not described elsewhere shall be 5/8 inch (1.6 cm) diameter by 8 feet (2.4 m) long, with a copper jacket bonded to a steel core. Minimum ground rods shall be three (3) per tower and shall be asymmetrical.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS. General installation requirements are described in Master Specification Section 17100, Computer Control System.

3.1.01 Radio Equipment. The radio equipment shall be mounted in field device enclosures or in a separate enclosure if needed. Separate enclosures shall be furnished with the same NEMA rating and color as the field device enclosure.

3.1.02 Functional Testing. As a minimum, the following functional tests shall be performed on the communications equipment.

3.1.03 Antenna Alignment. After each antenna is permanently installed, a power monitor shall be used to properly adjust the antenna for maximum signal strength. A written report on the monitoring results shall be submitted to the Engineer for review before the radios are placed into permanent operation.

3.1.04 Radio Frequency Check. After each radio has been installed but before it is placed into permanent operation, a frequency check shall be conducted to verify conformance with the specified tolerances. The frequency check shall be performed by a radio technician either employed or under subcontract to Contractor. A written report on the results of this check shall be submitted to the Engineer for acceptance.

3.1.05 Surge Suppressor Installation. Surge suppressors shall be bulkheads mounted on the radio enclosures and shall be suitable for the sizes of cable inside and outside the enclosures.

3.1.06 Installation of Grounding Materials. Electrical system grounding and equipment grounding shall be in compliance with the National Electrical Code.

3.1.07 Antenna Installation. Contractor shall provide and supervise the installation of antenna equipment at radio sites as indicated on the drawings. Damage to tanks or reservoirs caused by the installing Contractor shall be repaired to the Owner's satisfaction at Contractor's expense.

3.2. FCC LICENSE. One or more frequency licenses has been granted to the Owner by the FCC. The licensed frequencies and their effective dates are as required.

Because the FCC allows only eighteen months for construction, Contractor shall have at least 4 remote transceiver radios operational and communicating with a base radio or a repeater radio by the date as required.

End of Section

SECTION 17400

SOFTWARE CONTROL BLOCK DESCRIPTIONS

PART 1 - GENERAL

1.1 SCOPE. This section provides functional descriptions of the PLC and computer system software requirements for the plant control system. These descriptions are intended to provide an overview of the operating concept of the treatment plant process equipment rather than describing in detail every operating feature or interlock.

1.1.01 Control System. Master Specification Section 17100, Computer Control System, shall apply to all systems described in this section.

PART 2 - PRODUCTS

2.1 SOFTWARE. The software is specified in Master Specification Section 17250, Computer System Software.

PART 3 - EXECUTION

3.1 FUNCTIONAL REQUIREMENTS. Functional requirements shall be as follows.

3.1.01 Available Process Values. All process alarm, equipment status, and process variable values shall be available at any operator station.

3.1.02 Manual Entry of Data. The operator's station shall allow manual entry of laboratory data and other variables, which shall then be available for display and use in reports. Operator entered commands from any of the operator's station shall be logged at the operator's station.

3.1.03 Flow Values. Flow values shall be integrated, totalized, and stored in the PLC registers so that the values displayed on the operator's station and on the SCADA system will be identical.

3.1.04 System Failure. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its most fail-safe condition. Failure of any PLC or its communication shall be alarmed on the operator's station.

3.1.05 Personal Computer. The personal computer shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so that a temporary failure of the personal computer will not disrupt plant control.

3.1.06 Change-of-State Alarms. All PLC discrete output commands shall be compared with their respective process feedback status signal, where available, to verify proper execution. If the feedback status does not match the most recent output command (after an adjustable 2 to 90 second time delay), an alarm message shall be displayed on the operator station and the condition shall be logged as an alarm requiring operator acknowledgment.

3.2 SPECIFIC SOFTWARE FUNCTIONAL DESCRIPTIONS. The following paragraphs describe some specific functional requirements for various software control blocks in the plant control system. These descriptions are intended to provide an overview of the operational concept of the treatment plant process equipment rather than describing in detail every operating feature or interlock.

3.2.01 General Monitoring of Analog Input Signals (CB-1). Process variable signals shall be displayed at operator stations in scaled engineering units and shall be historically archived. Values shall be available for use in reports. Inputs which represent flow values shall be integrated by the computer software and the "totalized" flow value shall be available for display and use in reports. High and low alarms shall be assigned to process values, where appropriate.

3.2.02 General Monitoring of Discrete Input Signals (CB-2). Discrete input signals which represent equipment status shall be displayed on the operator stations. The running time for all motorized equipment shall be totalized and stored for use reports and maintenance programs. Alarm inputs shall be displayed and shall actuate the station audible alarm device, which requires local acknowledgment by a plant operator. Alarms shall be printed on the alarm printer, with the time and date of occurrence, and shall be archived.

3.2.03 RO Feed Control (CB-3). The RO feed pump shall be manually started, either locally or through the operator's station. The pump shall start at minimum speed and shall accelerate as required to maintain the preset product water flow rate. The flow set point shall be adjustable through the operator's station. High discharge pressure, high differential pressure across any stage, or low suction pressure shall be alarmed and shall cause the pump and the RO unit to shut down. High product conductivity or loss of chemical feed shall also shut down the unit. The pump discharge valve shall be interlocked as required to operate with the pump.

3.2.04 RO Brine Flow Control (CB-4). The brine (concentrate) valve shall remain open when the RO unit is off-line, but ready to operate. Upon sensing the RO feed pump running, the brine valve shall begin closing to maintain the brine flow rate at a preset ratio to the product flow rate. The ratio of brine to product water shall be adjustable through the operator's station.

3.2.05 RO Chemical Feed Control (CB-5). The acid and antiscalant feed systems shall be started manually, either locally or, preferably, through the operator's station. The acid metering pump feed rate shall be controlled to maintain the RO influent pH at the set point value (adjustable through the operator's station). The antiscalant metering pump feed rate will be paced from the plant influent flow signal. The ratio of antiscalant to water shall be adjustable through the operator's station. Low level in the acid day tank or antiscalant storage tank shall cause an alarm, and at low-low level the respective metering pumps shall shut down. High discharge pressure in a chemical feed line shall cause an alarm and shall cause the respective metering pump to shut down. The RO feed pumps shall not operate unless the chemical feed systems are operating.

Transfer of acid to the day tank shall be semiautomatic. A plant operator will initiate the transfer by pressing a momentary push button located near the day tank. The transfer pump shall then operate until the day tank is full. Low level in the day tank shall initiate an alarm and alert the operator to initiate a transfer before the low-low level switch stops the metering pump.

3.2.06 Product Water Pumping Control (CB-6). The product water pumps shall automatically start and stop based on water level in the product water storage reservoir. Each pump shall start and stop at different water levels, which will be determined later. Controls shall be designed to alternate the pumps in service. The pumps shall be stopped in a "first-on first-off" sequence.

High and low water levels in the reservoir shall be alarmed. Hard-wiring of pump controls to stop operation on low reservoir level will be provided under another contract.

End of Section

SECTION 17500

INSTRUMENTATION GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of all instrumentation equipment required for the Computer Control System as indicated in the Contract Documents.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings; as indicated on the instrument device schedule drawings; as indicated on the instrument device schedules attached to this section, or to Sections 17510 through 17550, as required.

1.1.01 Control System. All applicable requirements defined in Master Specification Section 17100, Computer Control System, shall apply to equipment and services provided under this section.

1.2 GENERAL. Contractor shall select equipment furnished under this section for its superior quality and the intended performance. An Installation Contractor will install all equipment in accordance with manufacturer's instructions. Equipment and materials used shall be subject to review and comply with following requirements.

1.2.01 General Equipment Requirements. The General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.02 Drawings. Supplementing this section, the drawings indicate locations and arrangement of instruments and enclosures, provide mounting details, and may show device schedules and other information regarding the connection and interaction with other equipment.

1.2.03 Governing Standards. Governing Standards for instruments shall be as indicated in Master Specification Section 17100, Computer Control System.

1.2.04 Corrosive Fluids. All parts, which are exposed to corrosive conditions, shall be made from corrosion resistant materials. Contractor shall submit certification that the instrument manufacture approves the selection of materials of primary elements which are in contact with the specified process fluid to be inert to the effects of the process liquid.

1.2.05 Elevation and Temperature. All instruments shall be designed to operate within a range of elevation and temperature as required.

1.2.06 Power and Instrument Signals. Unless otherwise indicated, electric power supply to the instrumentation equipment will be unregulated 120 volts ac. Unless otherwise indicated, all transmitted electronic analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.

1.2.07 Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

1.2.08 Interchangeability and Appearance. To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

1.2.09 Programming Devices. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup.

1.2.10 Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with Contractor's equipment drawings and shall be as close as practical to the tag numbers used on the project drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as specified.

PART 2 - PRODUCTS

2.1 INDIVIDUAL DEVICE SPECIFICATIONS. Individual instruments and related devices shall be provided as specified in one or more of the following Master Specification sections, as required:

17510 Panel Mounted Instrument Specifications

17520 Flow Instrument Specifications

17530 Pressure and Level Instrument Specifications

17540 Analytical Instrument Specifications

17550 Miscellaneous Instrument Specifications

PART 3 - EXECUTION

3.1 INSTRUMENTATION INSTALLATION REQUIREMENTS. Additional instrumentation installation requirements are specified in Master Specification Section 17100, Computer Control System. Instruments shall be installed and calibrated in accordance with the following requirements.

3.1.01 Field Calibration. After each instrument has been installed, a technical representative of Contractor shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. Refer to typical Instrument Calibration Report at end of this section.

3.1.02 Systems Check. A technical representative of Contractor shall participate in the checkout of instrumentation systems. Systems check requirements shall be as specified in Master Specification Section 17100, Computer Control System.

3.1.03 Installation Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by Contractor for the duration of the testing work and this test equipment will remain the property of Contractor.

3.1.04 Mounting of Field Instruments. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the drawings.

3.1.05 Leads into Buildings, Panels, and Housings. Arrange leads into buildings, panels, and housings so as to prevent water infiltration.

3.2 CUSTOMER TRAINING. Instrumentation training as specified in Master Specification Section 17100, Computer Control System.

INSTRUMENT NAME & SERVICE:		
BRAND & MODEL NO.:		
TAG OR LOOP NO.:		
INPUT/OUTPUT RANGE:		
INPUT	ACTUAL OUTPUT	DESIRED OUTPUT
PROPORTIONAL BAND:		
RESET:		
POSITION OF SWITCHES, JUMPERS, ETC.		
COMMENTS:		
DATE OF CALIBRATION: CALIBRATED BY:		
Great Lakes Water Authority	INSTRUMENT CALIBRATION REPORT	Figure 1-17500

End of Section

SECTION 17510

PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of instrumentation equipment required for the Computer Control System as indicated on the drawings and as required.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings; as indicated on the instrument device schedule drawings; as indicated on the instrument device schedules attached to Master Specification Section 17500, Instrumentation General Requirements or as required.

1.2 GENERAL. Contractor shall select the equipment furnished under this section for its superior quality and the intended performance. An Installation Contractor will install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the requirements specified in Master Specification Section 17500, Instrumentation General Requirements.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 INDIVIDUAL DEVICE SPECIFICATIONS. Individual instruments and related devices shall be provided as specified herein, and as required.

PART 3 - EXECUTION

3.1 INSTRUMENTATION INSTALLATION REQUIREMENTS. Instrumentation installation requirements shall be as specified in Master Specification Section 17500, Instrumentation General Requirements.

3.2 PANEL MOUNTED INSTRUMENT SPECIFICATIONS. The following instrument specifications shall be followed:

3.2.01 Recorder Station

Instrument Category:	Panel
Instrument Type:	Recorder station
Power Supply:	24 V dc or 120 V ac, 60 Hz with cord set and plug 120 V ac, 60 Hz for chart drive
Signal Input:	Standard panel instrument voltage signal into 250 ohms minimum
Signal Output:	N/A
Process Connection:	N/A
Classification:	NEMA 1
Description:	Station shall be miniature-case drawout type, nominally 6 inches (15.2 cm) high by 3 inches (7.6 cm) wide by not more than 25 inches (63.5 cm) deep. Split architecture systems in which display stations and electronic function modules are separately mounted in equipment racks are acceptable. Operator adjustments shall be accessible without disconnecting station from the process. Process variable indicating scales shall be readily exchangeable. Each station shall be individually fused. Recorder shall provide for one to three pens on a 4 inch (10 cm) thermal chart with an accuracy of 0.1 percent or better current or voltage. Chart shall provide not less than 15 days recording at .75 inches per hour (19 mm per hour). Chart system shall permit easy inspection and return to the recorder of previously recorded data. Recorders shall display not less than 4 hours of recorded data without withdrawing either the chart or the recorder from the case.
Manufacturer:	Westronics or approved equal
Special Requirements:	N/A

3.2.02 Indicator

Instrument Category:	Panel
Instrument Type:	Indicator
Power Supply:	120 V ac, 60 Hz
Signal Input:	4-20mA
Signal Output:	Dual 2 AMP Alarm Relays
Process Connection:	N/A
Classification:	N/A
Description:	Provide a Microprocessor based 3-1/2 or 4-1/2 digit panel mounted indicator with LED or LCD display, negative value and alarm indication. The indicator shall be keypad configurable to display the process variable in engineering units and provide monitoring and display of the minimum and maximum process value. Accuracy shall be 0.5 percent of reading 0.1 percent full scale with a response time less than 3.5 secs.
Manufacturer:	Red Lion, Newport or approved equal
Special Requirements:	Provide 4-1/2 digit indicator as required, where process range and accuracy demands it. For areas exposed to direct sunlight, displays shall have sunshades or movable covers.

3.2.03 CMAT

Instrument Category:	Panel
Instrument Type:	Single Loop Digital Control (CMAT)
Power Supply:	24 V dc or 120 V ac, 60 Hz
Signal Inputs:	Number: Analog - 2 Discrete - 3
Signal Output:	Voltage: 1-5 V dc std. calibration (1M ohm min.) non-isolated
Current:	4-20 mA (with 250 ohm dropping resistors)

Low Level:	T/C, mv-isolated
Digital:	opto-coupler, 24 V dc at 10 mA (max.)
Process Connection:	N/A
Classification:	NEMA 12
Description:	The single loop digital controller shall be a completely self-contained, stand-alone, microprocessor-based industrial PID loop controller capable of local manual, local automatic, or external control system control. It shall coordinate analog loop control between external control system control, local manual control, and local automatic control (computer/ manual/automatic/transfer or CMAT).

It shall be user configurable through the use of software. The software shall use function blocks that can be arranged by the user through simple commands. Organizing the function blocks into an operational program shall be a simple task and not require the operator to have previous programming experience. The CMAT shall programming keys or pushbuttons for directly entering programming commands, without the use of external programming equipment. The function blocks shall be internal to the controller, and allow the controller to be configured for any combination of control algorithms including feedback, feedforward, proportional, integral, derivative, ratio, and speed-floating.

The function blocks shall provide mathematical functions, Boolean functions, timers, internal transfer switches, alarms, track and hold functions, storage registers, analog to pulse converters, and a square root extractor. The software shall provide fully adjustable output limiting, prevent reset wind-up, and provide standard PID tuning parameters, including setpoint tracking without overshoot.

The loop controller shall allow direct digital control (DDC) of its output from an external control system. Under DDC control, the loop controller shall pass the control signal to the output without acting upon it with its own internal algorithm. The loop controller shall track the signal and provide bumpless switching between local and external control. The loop controller shall be capable of external setpoint control.

The loop controller shall be a miniature-case drawout type, nominally 6 inches (15.2 cm) high by 3 inches (7.6 cm) wide by not more than 25 inches (63.5 cm) deep. Operator adjustments and programming facilities shall be accessible from the front without disconnecting the station from the process.

The loop controller shall have a solid state vertical scale for displaying the process variable, setpoint, and output. This display shall clearly indicate the deviation from setpoint, process deviation alarms, and diagnostic alarms. Manual setpoint adjuster, manual output adjuster and mode selector shall be provided on the loop controller faceplate.

The loop controller shall provide control actions specified in the instrument schedule when in automatic mode. Control actions shall be as defined in ANSI/ISA S51.1. Where specified, proportional action shall be adjustable from 2 to 500 percent; integral action adjustable from 0.01 to 60 minutes per repeat; derivative action adjustable from 1 to 100 percent.

Controller accuracy shall be 0.5 percent of span or better.

Controller front panel shall be capable of being remotely mounted from controller body. Interconnection shall be via ribbon cable. Where the controller front panel is mounted separate from the controller body the Contractor shall provide an interconnecting ribbon cable.

Manufacturer: Moore Product Co., Mycro 352E, Foxboro 742, or approved equal.

Special The loop controller shall provide digital interface

Requirements:	signals for mode coordination with the external control system. The status of the signals, one digital input and one digital output, shall indicate whether the control system or the loop controller is available for control. Loss of the control system ready signal at the loop controller shall cause the loop controller to switch to local automatic mode using the last tracked setpoint value or process variable value as setpoint, and to not accept commands from the control system. Conversely, lack of the ready signal from the loop controller at the control system shall cause the control system to take control and notify the operator. Programming of the loop controller is the responsibility of the Contractor. The Contractor shall supply software for loading programs from personal computers. This software shall allow CMAT configuration programs to be stored, uploaded, downloaded, and edited.

3.2.04 Annunciator

Instrument Category:	Panel
Instrument Type:	Annunciator
Power Supply:	24 V dc/120 V ac, 60 Hz
Signal Input:	Dry Contact, 24 V dc; see Contract Drawings
Signal Output:	Dry Contact (2 amp @ 120 V ac)
Process Connection:	N/A
Classification:	NEMA 1
Description:	The annunciator shall be prewired so only power and external wiring need be connected to operate the system. All cables leading to and from the annunciator and plug-in components shall withstand an insulation test at a specified voltage and frequency to ground. The removal of individual active or spare stations shall not affect the operation of the other units nor shall live electrical leads become exposed. All annunciator

components shall be capable of withstanding transient voltage surges, from any possible source. Terminals and wires on or within the annunciator shall be clearly identified and shall relate directly to the schematics and wiring diagrams.

Auxiliary contacts shall be provided to facilitate all functions indicated on the Contract Drawings, such as providing a common alarm from multiple alarm inputs. The number of rows and columns is shown on the panel schedules. Mounting to be either panel front or wall as shown on the drawings. ISA Sequence AS shall be Windows shall be single or dual point as required. Logic shall be solid state, and located behind the panel with contact voltage of 24 V dc and contact type NO/NC to be switch selectable. The audible alarm shall be a solid state horn with volume control. Annunciator shall be complete with alarm acknowledge, reset and test push buttons.

Manufacturer:	AMETEK, Panalarm Series 90, BETA, RIS or approved equal.
Special Requirements:	N/A

End of Section

SECTION 17520

FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of instrumentation equipment required for Master Specification Section 17100, Computer Control System, as indicated on the drawings and as required.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings; as indicated on the instrument device schedule drawings; as indicated on the instrument device schedules attached to Master Specification Section 17500, Instrumentation General Requirements, or as required.

1.2 GENERAL. Contractor shall select the equipment furnished under this section for its superior quality and the intended performance. An Installation Contractor will install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the requirements specified in Master Specification Section 17500, Instrumentation General Requirements.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 INDIVIDUAL DEVICE SPECIFICATIONS. Individual instruments and related devices shall be provided as specified herein and as required.

PART 3 - EXECUTION

3.1 INSTRUMENTATION INSTALLATION REQUIREMENTS. Instrumentation installation requirements shall be as specified in Master Specification Section 17500, Instrumentation General Requirements.

3.2 FLOW INSTRUMENT SPECIFICATIONS. The following flow instrument specifications shall be followed:

3.2.01 Pitot Tube.

Instrument Category:	Flow
Instrument Type:	Pitot Tube, Averaging
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	As specified on drawings, schedule or manufactured design
Classification:	N/A
Description:	Pitot Tube Flow element shall be a differential producer of the impact pressure type with integral static and transverse averaging elements that eliminate the affects of pipe surface roughness. Differential pressure shall be proportional to flow rate squared with an accuracy of ±1 percent of actual flow or better. The flow element shall be selected to best fit the application while minimizing unrecovered head loss. The tube shall be Type 316 stainless steel, mounted through a single tap into the process line. The Contractor shall properly size the flow element based on actual flow conditions.
Manufacturer(s):	Dieterich Standard, Meriam Instrument or approved equal.

3.2.02 Flow Indicator/Switch.

Instrument Category:	Flow
Instrument Type:	Flow Indicator/Switch
	This technology may not be preferred by the Owner for some applications. In those instances, the DBM Contractor shall recommend available alternative technology in the design workshops, to the Owner for its review and acceptance.
Power Supply:	N/A

Signal Input:	N/A
Signal Output:	2 SPDT rated at 6 amps at 125 V ac
Process Connection:	3/4 inch NPT - female
Classification:	N/A
Description:	Flow indicator shall be of rugged construction, all electronic, using thermal mass technology. The unit shall have an all welded Type 316 stainless steel sensor head. The indicator shall have a temperature compensation circuit. Display shall be calibrated in gallons per minute. The switch shall have (2) SPDT relays.
Manufacturer(s):	FCE FLT93x series thermal flow switch with display or approved equal.
Special Requirements:	The Contractor to select range based on flow requirements of the application. Determine pipe size and select correct insertion length for each application. Submit a schedule or list for each application, that provides this information including a letter from the manufacturer verifying that the units are sized properly for the application.

3.2.03 Flow Switch – Paddle Type.

Instrument Category:	Flow
Instrument Type:	Flow Switch
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	Socket mount single channel rated at 2A 115 V ac
Process Connection:	1/2 inch NPT Female
Classification:	NEMA 4
Description:	Flow Switch shall be in line paddle type sensor with 316 ss paddle, bronze body, suitable for mounting in process streams without the need for expansion

	fittings or Tee's. This switch shall be used for installations in process piping of 1 inch or less.
Manufacturer(s):	W. E. Anderson, Flotect model V6 or approved equal.
Special Requirements:	The Contractor shall determine mounting and location requirements and submit to Contracting Officer for review and approval.

3.2.04 Flow Switch – Thermal Type.

Instrument Category:	Flow
Instrument Type:	Flow Switch
	This technology may not be preferred by the Owner for some applications. In those instances, the DBM Contractor shall recommend available alternative technology in the design workshops, to the Owner for its review and acceptance.
Power Supply:	24 V dc or 115 V ac
Signal Input:	N/A
Signal Output:	2 SPDT relays rated at 6 Amps @ 115 V ac
Process Connection:	1 inch NPT, 1-1/4 inch for packing gland assembly
Classification:	Explosion Proof or NEMA 4X
Description:	Provide bi-directional thermal type flow switch for FLOW - NO FLOW - REVERSE FLOW indication. The switch shall be made of 316 stainless steel with a pressure rating of 2000 psi. Operating temperature range shall be -100°F to +350°F.
Manufacturer(s):	GEMS, Model RF83 or approved equal.
Special Requirements:	As required, install switch with a retractable probe through a packing gland/ball valve assembly. Packing gland shall be constructed of Type 316 stainless steel. Include packing compression collar and nut. The ball valve shall be 1-1/4 inch full bore stainless steel. The valve can be threaded or flanged in accordance with Contracting Officer's

instructions. Size the assembly to accommodate the pipe. Use LPG assembly for 50 psi or less. Use MPG for 500 psi or less.

3.2.05 Ultrasonic.

Instrument Category:	Flow
Instrument Type:	Flow Element (Ultrasonic)
Power Supply:	Ultrasonic Transceiver
Signal Input:	Ultrasonic Transceiver
Signal Output:	N/A
Process Connection:	N/A
Classification:	NEMA 4X
Description:	Transducer shall be non-contacting ultrasonic sensor compatible with specified level/flow indicating transceiver. Transducer shall have integral temperature compensation and be constructed of Tefzel with a NEMA 4X rating. Ambient operating temperature range shall be -40°F to 160°F. Maximum range shall be 33 feet and maximum separation of transducer from transmitter shall be 1200 feet.
Manufacturer:	Milltronics STH or approved equal.
Special Requirements:	To ensure compatibility, the Contractor shall supply transducer in conjunction with a Milltronics HydroRanger or equal ultrasonic level transmitter.

3.2.06 <u>Flow Indicating Transmitter</u>.

Instrument Category:	Flow
Instrument Type:	Flow Indicating Transmitter
Power Supply:	120 V ac, 60 Hz
Signal Input:	Ultrasonic Transducer
Signal Output:	4-20 mA, 5-SPDT Form C Relays
Process Connection:	N/A
Classification:	NEMA 4X
Description:	Transmitter shall be a microprocessor based, ultrasonic level/flow monitor, and shall communicate with the specified ultrasonic transducer to produce a flow reading relative to process level. Unit shall be housed in a NEMA 4X enclosure and shall have front panel digital display of operating parameters and process conditions in operator selectable units. Programming and calibration shall be performed by a removable, magnetically mounted, infrared coupled, handheld programmer.
Manufacturer:	Milltronics HydroRanger, or approved equal.
Special Requirements:	To ensure compatibility, the Contractor shall supply flow transmitter in conjunction with a Milltronics model STH ultrasonic transducer.

3.2.07 <u>Flow Element/Transmitter</u>.

Instrument Category:	Flow
Instrument Type:	Flow Element/Transmitter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4 - 20 mA, 5-SPDT Form C Relays
Process Connection:	N/A

Classification:	See Description
Description:	Primary Flow Element shall be "H" type flume with fabricated mounting for circular sewers as needed for use in open channel sewage flow. Flume shall contain integrally mounted brackets spaced to support the secondary element.
	Secondary element shall be an ultrasonic transducer indicating transmitter configured for owner specified flows. The transducer shall contain integral temperature compensation, and be constructed of seamless Tefzel material in a NEMA 4X enclosure. Ambient operating temperature range shall be -40°F to 160°F. Maximum separation, transducer to transmitter, shall be at least 1200 feet.
	Transmitter shall be housed in NEMA 4X enclosure and shall have front panel digital display of operating parameters and process conditions in operator selectable units. Programming and calibration shall be performed by a removable, magnetically mounted, infrared coupled, hand held programmer. Transmitter shall accept the input of flume configurations and convert level measurement to an accurate flow reading.
Manufacturer:	Flume - Hinde Engineering or approved equal.
	Ultrasonic Transducer/Transmitter - Milltronics HydroRanger with STH transducer.
Special Requirements:	The Contractor is responsible for sizing and installation of the flume and mounting of the ultrasonic transducer in accordance with manufacturer’s recommended specifications and existing owner installations.

3.2.08 Flow Indicating Transmitter (PDT).

Instrument Category:	Flow
Instrument Type:	Flow Indicating Transmitter-(PDT)
Power Supply:	24 V dc for 0 to 600 ohms loading
Signal Input:	N/A
Signal Output:	4-20 mA dc, current regulated to drive loads of 0 to 550 ohms at 23 V dc
Process Connection:	1/2 inch NPT on 2-1/8 inch centers
Classification:	Explosion proof, corrosion resistant
Description:	The transmitter shall be a differential pressure device. The transmitter shall be a smart microprocessor-based unit capable of square root extraction and onboard integration. The transmitter shall be capable of communication with a hand held remote transmitter interface using HART digital communication protocol over its 24 V dc loop powered two wire system. The Transmitter shall be available in adjustable ranges from 5 inch wc to 2000 psi. Static pressure rating shall be 2000 psig or greater. External adjustable zero and span shall be provided, adjustable over a 400:1 range or greater. Volumetric displacement at maximum span shall not exceed 0.01 cubic inch. Fill fluid shall be silicone oil. Adjustable damping shall be provided. Transmitter shall have a digital indication of process measurement in appropriate flow units on a 4-1/2 digit LCD display. Unless otherwise specified, wetted parts shall be Type 316 stainless steel. Accuracy shall be ±0.25 percent of span. Housing shall have separate electronic assembly and wiring compartments. Temperature limits shall be -40°F to 185°F.
Manufacturer:	Rosemount3051, SMAR, LD-301, ABB or approved equal.
Special	Provide block/isolation valves three-valve manifold

Requirements:	type instrument valves, mounting brackets and accessories. Provide isolation diaphragm where necessary.

3.2.09 Flow Indicating Transmitter (PDT).

Instrument Category:	Flow
Instrument Type:	Flow Indicating Transmitter - (PDT)
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	1/2 inch NPT on 2-1/8 inch centers
Classification:	NEMA 7
Description:	Transmitter shall be a two-wire system, and measure pressure by detecting the force on an integral capacitance diaphragm capsule. Transmitter shall be capable of square root extraction. Transmitter shall be available in adjustable ranges from 5 inch wc to 6000 psi. Static pressure rating shall be 2000 psig or greater. External adjustable zero and span shall be provided, adjustable over a 5:1 range or greater. Volumetric displacement at maximum span shall not exceed 0.01 cubic inch. Fill fluid shall be silicone oil. Adjustable damping shall be provided. Transmitter shall have integral digital LCD display of process measurement in appropriate flow units. Display shall have 3-1/2 or 4-1/2 digit resolution. Unless otherwise specified, wetted parts shall be Type 316 stainless steel. Accuracy shall be ±0.25 percent of span. Housing shall have separate electronic assembly and wiring compartments. Temperature limits shall be -40°F to 185°F.
Manufacturer:	Rosemount 3051DP, SMAR LD-301, Foxboro, Honeywell or approved equal.

3.2.10 Magnetic Flow Meter.

Instrument Category:	Flow
Instrument Type:	Magnetic Flow Meter (Wafer Style)
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA into 600 ohms at 24 V dc
Process Connection:	As specified on drawings and schedules, or as required to meet the requirements of the application.
Classification:	NEMA 4, 4X for corrosive atmosphere, Provide instrument systems rated for Class 1, Division 1; or Class 1, Division 2 environment where applicable.
Description:	Flow metering system shall include a wafer style flow tube and a Transmitter. Transmitter shall include a separate converter complete with all necessary interconnecting cables. Transmitter shall be suitable for full scale flow rates from 0.3 to 33 feet per second. Provide system accuracy of 0.5 percent of indicated flow. Power supply shall be 120 volts ±10 percent, 60 Hertz ±3 Hertz.
FLOW TUBE:	Unless incompatible with process fluid or otherwise specified, flow tube shall be Teflon PFA liner molded on stainless steel punch plate assembly, wafer style body from 1/2 inch to 6 inch, ANSI 150 lb bond rating. Electrodes shall be Type 316 stainless steel or Hasteloy C standard. Provide special electrodes if application requires. Provide each meter with grounding rings, electrodes will not be acceptable. Flow tube power shall be supplied by transmitter. Flow tube shall be painted with corrosion resistant epoxy paint.
TRANSMITTER:	Transmitter shall provide 4-20 mA as specified above. Provide HART protocol communication capabilities. Span adjustments, PV signal selection, damping, flow unit selection, and all other adjustments shall be by menu selectable field communicator, or local display.

	Transmitter shall be provided with an integral indicator with LED or LCD display. The transmitter shall allow for the selection of percent of span, flow rate, or totalization.
Manufacturer(s):	Krohne, ABB, or approved equal
Special Requirements:	The Contractor is responsible for sizing flow tube and selecting materials to be compatible with the process.

3.2.11 Transmitter.

Instrument Category:	Flow
Instrument Type:	Transmitter
Power Supply:	As Required
Signal Input:	As Required
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	N/A
Description:	The Contractor shall determine and provide transmitter or conversion module compatible with existing primary elements to provide scalable 4-20 mA output in engineering units. Transmitter shall conform to the classification of the area in which it shall be located. Existing instruments and process shall remain in tact unless otherwise annotated on schedules or drawings.
Manufacturer(s):	As Required
Special Requirements:	Upon selection of appropriate instrument, the Contractor shall submit all drawings and specifications for Contracting Officer's review prior to purchase.

3.2.12 Flow Switch – Indicating.

Instrument Category:	Flow

Instrument Type:	Flow Switch - Indicating
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	2 Switch Contacts 15A/125 V ac SPDT Field Adjustable
Process Connection:	1/8 inch to 2 inch NPT
Classification:	NEMA 4, NEMA 4X for Corrosive Areas
Description:	Variable area flow meter with indicator and switches. Indicator and switches actuated by swinging vane in a variable area. Low flow units actuated by piston and linkage. Pressure rating of housing 150 psi minimum.
Manufacturer(s):	Gems or approved equal.
Special Requirements:	The Contractor shall size unit for flow application. Scale to be selected based on flow requirements. Note: These units to be used only in potable or secondary water applications. In lines subject to scale or other particulate an upstream strainer shall be used. The Contractor shall select and size to fit application.

3.2.13 Magnetic Flow Meter.

Instrument Category:	Flow Measurement
Instrument Type:	Magnetic Flow Meter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA dc, isolated with damping. Optional pulse or scaled frequency
Process Connection:	Mounting between ANSI, AWWA, DIN, BS Flanges; 1/10 inch to 4 inch nominal sizes
Classification:	NEMA 7

Description:	Microprocessor based with aluminum oxide (ceramic) liner and selectable electrode material. Built-in grounding electrodes. Ultra high impedance measurement circuitry. No external electrode cleaning required. Bi-polar pulsed DC coils. Low flow cut off. Minimum velocity 0.3 fps. Accuracy ±1 percent of rate from 1-33 fps. Automatic rezero.
Manufacturer(s):	Krohne, Endress & Hauser, ABB, Sparling Instruments Co. or approved equal.
Special Requirements:	The Contractor to size flow tube according to flow application. Manufacturer to provide application performance guarantee. Manufacturer to provide certified wet calibration.

3.2.14 Magnetic Flow Meter.

Instrument Category:	Flow
Instrument Type:	Magnetic Flow Meter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA dc, isolation and damping included. Optional pulsed or scale frequency output.
Process Connection:	125/150 1b. ANSI Flanges, 1/4 inch to 72 inch diameter
Classification:	NEMA 4, 4X for corrosive atmosphere
Description:	Bipolar DC pulsed coil excitation with auto zero, low flow cut off and empty pipe detection. Ultra high impedance measurement circuitry. No external electrode cleaning required. Minimum conductivity of 1 micromho/cm. Minimum velocity of 1.0 fps. Accuracy ±0.5 percent of rate. Accidental submergence proof. Operating temperature range minimum: -20° to +120°F.
Manufacturer(s):	Krohne, Endress & Hauser, ABB or approved equal.

Special Requirements:	The Contractor shall size flow tube and select liner material and electrodes according to flow application. Manufacturer to provide application performance guarantee and certified wet calibration.

3.2.15 Rotometer.

Instrument Category:	Flow
Instrument Type:	Variable Area Flow Meter (Rotometer)
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	150 # ANSI Flat Face Flange or to fit existing process piping
Classification:	NEMA 4X Meter Enclosure
Description:	Variable area flow meter unit to be straight through flow construction with PVC (Type 1, Grade 1) wetted parts (except float). Float material shall be compatible with process fluid and shall be factory sized for flow parameters of the application. Full scale, maximum flow shall be 100 percent.
Manufacturer(s):	Brooks, Wallace & Tiernan, or approved equal.
Special Requirements:	The Contractor shall provide flow material and line information for the vendor to properly size each unit for its application.

End of Section

SECTION 17530

PRESSURE AND LEVEL INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of instrumentation equipment required for Master Specification Section 17100, Computer Control System, as indicated on the drawings and as required.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings; as indicated on the instrument device schedule drawings; as indicated on the instrument device schedules attached to Master Specification Section 17500, Instrumentation General Requirements, or as required.

1.2 GENERAL. Contractor shall select the equipment furnished under this section for its superior quality and the intended performance. An Installation Contractor will install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the requirements specified in Master Specification Section 17500, Instrumentation General Requirements.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 INDIVIDUAL DEVICE SPECIFICATIONS. Individual instruments and related devices shall be provided as specified herein, and as required.

PART 3 - EXECUTION

3.1 INSTRUMENTATION INSTALLATION REQUIREMENTS. Instrumentation installation requirements shall be as specified in Master Specification Section 17500, Instrumentation General Requirements.

3.2 PRESSURE AND LEVEL INSTRUMENT SPECIFICATIONS. The following pressure and level instrument specifications shall be followed:

3.2.01 Bubbler Assembly.

Instrument Category:	Level
Instrument Type:	Bubbler Assembly
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	N/A
Classification:	N/A
Description:	Air Purge Rotameter Assembly: Air purge rotameter assembly shall consist of a constant-differential relay, needle valve, check valve and 0.2 to 2.0 standard cubic feet per hour (scfh) rotameter. High Pressure Purge Valve: Valve shall be a 3/8 inch, three-way, three-position solenoid valve with Type 316 stainless steel body and ball and teflon seats. In the "normal" position, back pressure from the bubble pipe shall be passed to the pressure instrument. In the "bleed" position, all ports shall be sealed. In the purge position, the instrument port shall be sealed and air sent to the bubble pipe. Nameplates shall be provided to define each position. Nameplates shall have black baked enamel letters on anodized aluminum plate. Bubble Pipe: Bubble pipe shall be 3/4 inch, Schedule 80, PVC. Bubble pipe shall be provided with two pipe tees at the top for connection of air purge supply line and static line. Top opening shall be provided with threaded plug for rodding out the bubble pipe. The bottom end of the bubble pipe shall be notched approximately 3/4 inch deep by 1/2 inch wide.
Manufacturer(s):	Conoflow, Model DH21-12 Rotometer, Conant or equal three-way valve. or approved equal
Special Requirements:	N/A

3.2.02 Level Sensor with Temperature Compensation.

Instrument Category:	Level
Instrument Type:	Level Sensor w/Temperature Compensation
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	N/A
Description:	The unit shall consist of a submersible level sensor/transmitter utilizing silicon piezoresistive sensing technology. The sensor head shall be a non-clogging design constructed of 316 stainless steel. The sensor assembly shall be oil filled with a stainless steel diaphragm isolating the sensor from the process media.
Manufacturer:	Ametek Model 575, Druck, or approved equal.
Special Requirements:	The Contractor shall provided stilling pipes or wells for mounting and protection of the sensor based on the application and manufacturer’s recommendations. The Contractor shall select the proper sensing range and cable length, and shall mount the sensor such that it may be easily removed from the process for maintenance.

3.2.03 Level Indicating Transmitter (Diaphragm) .

Instrument Category:	Level
Instrument Type:	Level Indicating Transmitter (Diaphragm)
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA dc, current regulated to drive loads of 0 to 550 ohms at 23 V dc

Process Connection:	3 inch flange, Class 1500, raised face
Classification:	Explosion proof, Corrosion resistant
Description:	Transmitter shall measure level by detecting the force on a diaphragm flange mounted to the side of a vessel. Provision shall also be made for connecting an equalizing connection to the backside of the diaphragm to permit level measurement in pressurized vessels. Transmitter shall provide visual indication of percent (percent) filled on a 4-1/2 character display. Extended diaphragms shall be provided where specified to place the diaphragm flush with the interior wall of the vessel. Unless otherwise specified or incompatible with the process fluid, wetted parts shall by Type 316 stainless steel. Accuracy shall be 0.5 percent and repeatability 0.1 percent of span. Provide unit with Hart Protocol communication circuitry installed.
Manufacturer:	Rosemount 3051LT, SMAR, Endress and Hauser, ABB or approved equal.
Special Requirements:	Flange static pressure to be determined by The Contractor.

3.2.04 Level Switch (Radio Frequency).

Instrument Category:	Level
Instrument Type:	Level Switch (Radio Frequency)
	This technology may not be preferred by the Owner for some applications. In those instances, the DBM Contractor shall recommend available alternative technology in the design workshops, to the Owner for its review and acceptance.
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	Contacts as specified below
Process Connection:	3/4 inch male NPT

Classification:	N/A
Description:	Switch shall be the radio frequency admittance type resistant to buildup of material on the probe surface. Wetted materials shall be Type 316 stainless steel and Teflon unless otherwise specified. Setpoint and reset point shall be fully adjustable. Sensitivity and repeatability shall be 0.1 inch or better. Include level sensor, level control and receiver as required to provide the appropriate number of single pole double throw alarm/control contacts. Each contact shall be rated for 5 amps at 120 V ac.
Manufacturer(s):	Drexelbrook 506 Series, Endress and Hauser or approved equal.
Special Requirements:	N/A

3.2.05 Level Indicating Transmitter.

Instrument Category:	Level
Instrument Type:	Level Indicating Transmitter
	This technology may not be preferred by the Owner for some applications. In those instances, the DBM Contractor shall recommend available alternative technology in the design workshops, to the Owner for its review and acceptance.
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	3/4 inch NPT or as appropriate for the application.
Classification:	NEMA 4
Description:	Capacitance level indicating transmitter shall be a two wire unit that monitors changes in level by converting media movement on its sensing probe into a 4-20 mA analog output proportion to change

	in level. Transmitter shall provide digital indication of percent full. Operating temp shall be -40° to 75°C with ±1 percent accuracy.
Manufacturer(s):	Magnetrol Kotron, Drexelbrook Engineering Series 508, or approved equal.
Special Requirements:	Probe shall be PTFE coated or Owner approved equal. The Contractor shall determine appropriate probe length, material and configuration for each specified application.

3.2.06 Level Switch (Capacitance).

Instrument Category:	Level
Instrument Type:	Level Switch (Capacitance)
	This technology may not be preferred by the Owner for some applications. In those instances, the DBM Contractor shall recommend available alternative technology in the design workshops, to the Owner for its review and acceptance.
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	DPDT, 115 V ac, 10 A, Noninductive
Process Connection:	3/4 inch NPT
Classification:	NEMA 1 through 5 and NEMA 12. Explosion Proof for all groups Division 1 & 2 or otherwise as required to meet the requirements of the area in which the instrument is being installed.
Description:	Level Switch shall be capacitance type utilizing solid state circuitry designed to compensate for build up of conductive material on the probe. Switch electronics shall have versatility of using either rigid or flexible probe, dependant on depth of measured media. Switch design shall provide for single, dual or triple setpoints functionality, with associated zero span and differential adjustments. Ambient operating temperature range shall be -40° to 60°C.

Manufacturer:	Endress & Hauser; Drexelbrook Engineering, Series 506; Magnetrol Kotron or approved equal.
Special Requirements:	The Contractor is responsible for determining application specific options and probe length. Submit selected unit complete with all options to the Contracting Officer for review and approval.

3.2.07 Level Switch (Ultrasonic).

Instrument Category:	Level
Instrument Type:	Level Switch (Ultrasonic)
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	SPDT, 120 V ac
Process Connection:	3/4 inch NPT
Classification:	NEMA 7/9
Description:	Level Switch shall be an ultrasonic tip sensitive design with built-in signal averaging circuit to reject effects of turbulence and effervescence. Repeatability shall be not less than 0.078 inch typical. Transducer shall be 316 stainless steel with activation lengths available from 1 to 100 inch. Transducer shall operate in an environment of up to 1500 psi at -40° to 250°F. Ambient operating temperature range for electronics shall be -40° to 160°F.
Manufacturer:	Endress & Hauser; Magnetrol, Series 910 or approved equal.
Special Requirements:	The Contractor is responsible for determining activating lengths as per drawings and field surveys.

3.2.08 Level Transducer (Ultrasonic).

Instrument Category:	Level

Instrument Type:	Level Transducer (Ultrasonic)
Power Supply:	Ultrasonic Transducer
Signal Input:	Ultrasonic Transducer
Signal Output:	N/A
Process Connection:	N/A
Classification:	NEMA 4X
Description:	Transducer shall be non-contacting ultrasonic sensor compatible with specified level indicating transmitter. Transducer shall have integral temperature compensation and be constructed of Kynar with a NEMA 4X rating. Ambient operating temperature range shall be -40°F to 203°F. Maximum range shall be 100' and maximum separation of transducer from transmitter shall be 1200'.
Manufacturer:	Milltronics XPS-30, or approved equal.
Special Requirements:	To ensure compatibility, the Contractor shall supply transducer in conjunction with a Milltronics AiRanger ultrasonic level transmitter.

3.2.09 Level Inidicating Transmitter (Ultrasonic).

Instrument Category:	Level
Instrument Type:	Level Indicating Transmitter (Ultrasonic)
Power Supply:	120 V ac, 60 Hz
Signal Input:	Ultrasonic Transducer
Signal Output:	4-20 mA, 750 ohm max.
Process Connection:	N/A
Classification:	NEMA 4X
Description:	The level indicating transmitter shall be microprocessor based and compatible with the level transducer selected per Instrument Specification Sheet 17530-3.19. Transmitter shall have an LCD digital display and indicate in user selectable units. At least 4, Form C, SPDT, user programmable, alarm relays shall be supplied. Programming and calibration shall be performed by a removable, magnetically mounted, infrared coupled, handheld programmer. Accuracy shall be ±0.25 percent of range, and operating temperature range shall be -20°F to 130°F.
Manufacturer:	Milltronics AiRanger SPL, or approved equal.
Special Requirements:	To ensure compatibility, the Contractor shall supply level transmitter in conjunction with a Milltronics XPS-30 ultrasonic transducer.

3.2.10 Level Switch (Float).

Instrument Category:	Level
Instrument Type:	Level Switch (Float)
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	N/A

Process Connection:	N/A
Classification:	NEMA 4X
Description:	Level switch shall be hermetically-sealed, axially non-position sensitive mercury switch housed inside polypropylene float. Switch operating angle shall not be greater than 18 degrees activating a SPDT 15A contact. Tether length to be determined by application.
Manufacturer:	Consolidated, B & W Controls, FLYTE, Anchor Scientific or approved equal.
Special Requirements:	The Contractor shall determine tether length for each application by drawings, schedules, or field verification of operating conditions. Provide intrinsic barriers or isolation as required by area classification.

3.2.11 Level Indicating Transmitter (PDT).

Instrument Category:	Level
Instrument Type:	Level Indicating Transmitter-(PDT)
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA, current regulated to drive loads of 0 to 550 ohms at 23 volts DC
Process Connection:	1/2 inch NPT on 2-1/8 inch centers
Classification:	Explosion Proof, corrosion resistant
Description:	Transmitter shall be a smart two-wire system, and measure pressure by detecting the force on an integral capacitance diaphragm capsule. The smart transmitter shall be available in adjustable ranges from 5 inch wc to 2000 psi. Static pressure rating shall be 2000 psig or greater. External adjustable zero and span shall be provided, adjustable over a 5:1 range or greater. Volumetric displacement at maximum span shall not exceed 0.01 cubic inch.

	Fill fluid shall be silicone oil except where incompatible with the process. Adjustable damping shall be provided. Transmitter shall have integral Digital LCD Display of process measurement in appropriate engineering units. Display shall have 4-1/2 digit resolution. Unless otherwise specified, wetted parts shall be Type 316 stainless steel. Accuracy shall be ±0.25 percent of span. Housing shall have separate electronic assembly and wiring compartments. Temperature limits shall be -40°F - 185°F. Provide unit with Hart Protocol communication circuitry installed.
Manufacturer:	**Rosemount 3051 DP, SMAR**, , Endress and Hauser, ABB, Honeywell or approved equal
Special Requirements:	Provide block/isolation valves, mounting brackets and accessories. Provide an isolation diaphragm where necessary.

3.2.12 Float Type Liquid Level Switch.

Instrument Category:	Level
Instrument Type:	Float Type Liquid Level Switch
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	Two DPDT Switch Rated for 15 amp, 125 V ac
Process Connection:	1 inch NPT
Classification:	NEMA 4
Description:	Liquid level switch designed for vertical mounting in a tank or vessel. Switch mechanism is activated by magnetic field of a magnet positioned by the float. Non-magnetic barrier isolates process liquid from switch mechanism. This unit intended for use in clean liquids that will not cause fouling of hinge mechanism. Activation travel approximate 1.5 inch.
Manufacturer:	Magnetrol International Model T20 or approved equal.

Special Requirements:	The Contractor shall select proper switch based on installation application. Float placement shall be determined by activation and desired level limits.

3.2.13 Level Switch – Vibrating

Instrument Category:	Level
Instrument Type:	Level Switch - Vibrating
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	SPDT Relay - Contacts 2A at 120 Vac
Classification:	NEMA 4 (min)
Description:	Single point level switch for granular or bulk solids and powders using damped oscillation method of measurement. Materials touching media shall be 316 stainless steel unless stated otherwise. Switch must tolerate operation in vessels or silos equipped with vibrators (electronics may be mounted off vessel). Maximum operating temperature shall be 200°F. Unit shall be provided with adjustable time delay.
Manufacturer(s):	Dynatrol (Automation Products, Inc.) CL-10DJ Series, Endress & Hauser LSM-1700 Series or approved equal.
Special Requirements:	The Contractor shall be responsible for determining the correct installation requirements for each application. Special information required by the vendor shall be provided to the vendor by the Contractor.

3.2.14 Level Indicating Transmitter (Continuous).

Instrument Category:	Level
Instrument Type:	Level Indicating Transmitter (continuous)
Power Supply:	24 V dc

Signal Input:	N/A
Signal Output:	4-20 mA dc
Process Connection:	1 inch max
Classification:	NEMA 4
Description:	This level transmitter shall be a two wire transmitter that provides an adjustable 4-20 mA output proportional to the change of granular or dry bulk materials in a vessel or silo. Included shall be compensation circuitry that corrects for changes in material composition, moisture and material build up on the probe. Operating temperature shall be from -40°F to +160°F. Maximum temperature effects shall be 2 percent/100°F change. Local indication shall be provided. Span shall be adjustable from 3 feet to 200 feet (minimum). Temperature rating shall be 250°F.
Manufacturer(s):	Milltronic Multiranger or approved equal
Special Requirements:	If the sensor utilizes contact type technology, the probe assembly (sensor) shall be coated to minimize the effects of abrasion, contamination, or build-up. The Contractor shall be responsible for determining the correct instrument configuration, for each installation. Venders application/technical data forms for each measurement location shall be completed by the Contractor and submitted to the Contracting Officer for approval. A letter from the manufacturer is required for each application of this instrument. The letter will stipulate that the product selected is appropriate for the application.

3.2.15. Level Switch.

Instrument Category:	Pressure
Instrument Type:	Level switch
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2 inch NPT - male
Classification:	NEMA 1 (or better)
Description:	Level switch shall be a pressure type modular unit consisting of a pressure transducer that shall be the diaphragm piston type with wetted materials as recommended by the switch manufacturers. Switch assembly shall be a hermetically sealed snap action with fully adjustable set and reset points. Setpoint shall be between 50 and 75 percent of maximum range. Switches shall be SPST or SPDT rated 5 amps at 115 volts; 2 amps at 230 volts AC. Setpoints shall be indicated on calibrated scales visible and adjustable from outside the housing. Scale accuracy shall be within 3 percent and repeatability within 1 percent of full scale. Bottom pressure connection and mounting bracket.
Manufacturer:	United Electric, Ashcroft, Automatic Switch Co., Tripoint, SOR or approved equal.
Special Requirements:	N/A

3.2.16 Differential Pressure Switch.

Instrument Category:	Pressure
Instrument Type:	Differential Pressure Switch
Power Supply:	N/A

Signal Input:	N/A
Signal Output:	DPDT switch rated for 5 AMP res. 250 Vac minimum
Process Connection:	1/4 inch NPT
Classification:	NEMA 4
Description:	Differential pressure switch for general service. Switch may be mounted in any position. Repeatability of $\pm$1 percent of full operating range. Adjustable deadband: maximum full range, minimum less than 10 percent of full operating range. Adjustments shall be external with scale. Temperature rating of unit shall be -4ºF to 140ºF minimum. 3/4 inch conduit hub to be provided.
Manufacturer:	Automatic Switch Company (Tripoint); United Electric; S.O.R. or approved equal.
Special Requirements:	The Contractor shall select proper range for application. The Contractor shall determine whether direct mounting (on process line or device) or remote mounting with tubing connections is appropriate. Selection of "wetted" part material shall be the Contractor’s responsibility.

3.2.17 Pressure/Differential Pressure Transmitter.

Instrument Category:	Pressure
Instrument Type:	Pressure/Differential Pressure Transmitter
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA dc, current regulated to drive loads of 0 to 550W at 23 V dc
Process Connection:	1/2 inch NPT on 2-1/8 inch centers
Classification:	Explosion proof, corrosion resistant
Description:	Transmitter shall be a two wire system, and

	measure pressure by detecting the force on an integral capacitance diaphragm capsule. Static pressure rating shall be 2000 psig or greater. External adjustable zero and span shall be provided, adjustable over a 5:1 range or greater. Volumetric displacement at maximum span shall not exceed 0.01 cubic inch. Fill fluid shall be silicone oil except where incompatible with the process. Adjustable damping shall be provided. Transmitter shall have integral Digital LCD Display of process measurement in appropriate engineering units. Display shall have 4-1/2 digit resolution. Unless otherwise specified or incompatible with the materials of the process, wetted parts shall be Type 316 stainless steel. Accuracy shall be ±0.25 percent of span. Housing shall have separate electronic assembly and wiring compartments. Temperature limits shall be -40°F -185°F. Provide unit with Hart Protocol communication circuitry installed.
Manufacturer:	**Rosemount 3051, SMAR,** Endress and Hauser, ABB, Honeywell, or approved equal.
Special Requirements:	Provide block/three-valve manifold isolation valves, mounting brackets and accessories. Provide isolation diaphragm where necessary.

3.2.18 Pressure Switch.

Instrument Category:	Pressure
Instrument Type:	Pressure switch
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2 inch NPT - male
Classification:	NEMA 1 or as required based on environmental conditions
Description:	Pressure switch shall be a modular unit consisting

	of a pressure transducer that shall be the diaphragm piston type with wetted materials as recommended by the switch manufacturers. Switch assembly shall be a hermetically sealed snap action with fully adjustable set and reset points. Setpoint shall be between 50 and 75 percent of maximum range. Switches shall be SPST or SPDT rated 5 amps at 115 volts; 2 amps at 230 volts AC. Setpoints shall be indicated on calibrated scales visible and adjustable from outside the housing. Scale accuracy shall be within 3 percent and repeatability within 1 percent of full scale. Bottom pressure connection and mounting bracket.
Manufacturer:	Automatic Switch Co., Tripoint, SOR, United Electric or approved equal.
Special Requirements:	N/A

3.2.19 Pressure Transmitter.

Instrument Category:	Pressure
Instrument Type:	Pressure Transmitter
Power Supply:	24 V dc
Signal Input:	0-3 to 0-5000 psi (8 ranges)
Signal Output:	4-20 mA (600 ohms at 24 V dc supply)
Process Connection:	1/2 inch NPTF
Classification:	FM & CSA Explosion proof
Description:	General purpose, low cost pressure transmitter featuring all stainless steel construction. Turndown ratio, 5:1. Temperature compensation from -20°F to 180°F, relative humidity to 100 percent. Accuracy $\pm$0.25 percent of calibrated span. Fluid fill is DC 200 Silicone.
Manufacturer:	**Rosemount, SMAR,** Ametek Model 88C or approved equal.
Special	The Contractor shall select proper range to cover

Requirements:	expected operating conditions allowing adequate turndown and range adjustment. The Contractor shall confirm compatibility of 316 stainless steel with process medium.

3.2.20 Pressure Indicating Switch.

Instrument Category:	Pressure
Instrument Type:	Pressure Indicating Switch
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA, 2 Independent SPDT Relays
Process Connection:	1/4 inch Female NPT
Classification:	NEMA 4X
Description:	The pressure switch shall be electronic with at least seven selectable input ranges from 0-15 to 0-3000 psig. The pressure switch shall have at least two field selectable setpoints. The indicator shall be LCD for process indication and red and green LED for setpoints 1 and 2, user selectable. The pressure switch shall employ jumper selectable rising/falling pressure setpoint energize/de-energize in addition to fail safe mode for loss of supply power. External adjustment shall be provided for setpoint calibration, zero offset and span movement such that neither process nor supply isolation is required. The electronics and power/output terminal shall be isolated in separate compartment shielded from RFI and EMI Operating ambient temperature shall be -29 to 71°C. Temperature effect shall be 61 percent per 100°F. Zero shall be 0-40 percent of range; span 20-100 percent of range; setpoint(s) 0-100 percent of range.
Manufacturer:	United Electric, SOR EPSII or approved equal.
Special Requirements:	4-20 mA output from an analog sensor may be used.

3.2.21 Pressure Indicator.

Instrument Category:	Pressure
Instrument Type:	Pressure Indicator
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2 inch NPT Bottom or back connection as applicable for installation.
Classification:	N/A
Description:	Provide 6 inch dial, stainless steel case, stainless steel polished ring, and 316 stainless steel Bourdon tube, tip and socket. Dial range calibration shall be in PSIG, INHG or FTWC of appropriate ranges. Accuracy shall be accuracy grade 2A ($\pm$0.5 percent of span). The Contractor to provide dial calibration in accordance with drawings, or Contracting Officer approved range based on field calibration.
Manufacturer:	Ashcroft, Ametek-U.S. Gauge, Marshalltown, Trerice, or approved equal.
Special Requirements:	Liquid fill required for all gauges used at process points subject to pressure pulsations or surges.

3.2.22 Pressure Indicator.

Instrument Category:	Pressure
Instrument Type:	Pressure Indicator
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	1/2 inch NPT, Bottom Connection
Classification:	General for corrosive environments

Description:	4-1/2 inch white coated dial with black scales, Turret style glass filled polypropylene, or fiberglass reinforced thermoplastic case, threaded ring front, 316 stainless steel internal movement, tube assembly, and socket. Calibration adjustment shall be provided. Safety blowout to rear of gauge shall be included. Gauge shall be made in accordance with ANSI B40.1, accuracy grade 2A (±0.5 percent of span) or better. The Contractor to provide dial calibration in accordance with drawings, or Contracting Officer approved range based on field calibration.
Manufacturer:	Ametek-U.S.Gauge, Aschroft, Marshalltown, Trerice, Wika, or approved equal
Special Requirements:	Liquid fill required for all gauges used at process points subject to pressure pulsations or surges.

3.2.23 Vacuum Switch.

Instrument Category:	Pressure
Instrument Type:	Vacuum Switch
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	DPDT, switch rated for 5 AMP res. 250 V ac minimum
Process Connection:	1/4 inch NPT
Classification:	NEMA 1 or classification compatible with environmental conditions
Description:	Vacuum switch for general service. Switch may be mounted in any position. Repeatability of ±1 percent of full operating range. Adjustable deadband: maximum full range, minimum less than 10 percent of full operating range. Adjustments shall be external with scale. Temperature rating of unit shall be -4°F to 140°F minimum. Three-fourth inch conduit hub to be provided.

Manufacturer:	Automatic Switch Company, Tripoint, United Electric or approved equal.
Special Requirements:	The Contractor shall select proper range for application. The Contractor shall determine whether direct mounting (on process line or device) or remote mounting with tubing connection is appropriate. Selection of "wetted" part material shall be the Contractor's responsibility.

End of Section

SECTION 17540

ANALYTICAL INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of instrumentation equipment required for Master Specification Section 17100, Computer Control System, as indicated on the drawings and as required.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings; as indicated on the instrument device schedule drawings; as indicated on the instrument device schedules attached to Master Specification Section 17500, Instrumentation General Requirements, or as required.

1.2 GENERAL. Contractor shall select the equipment furnished under this section for its superior quality and the intended performance. An Installation Contractor will install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the requirements specified in Master Specification Section 17500, Instrumentation General Requirements.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 INDIVIDUAL DEVICE SPECIFICATIONS. Individual instruments and related devices shall be provided as specified herein and as required.

PART 3 - EXECUTION

3.1 INSTRUMENTATION INSTALLATION REQUIREMENTS. Instrumentation installation requirements shall be as specified in Master Specification Section 17500, Instrumentation General Requirements.

3.2 ANALYTICAL INSTRUMENT SPECIFICATIONS. The following analytical instrument specifications shall be followed:
3.2.01 Dissolved Oxygen.

Instrument Category:	Analyzers
Instrument Type:	Dissolved oxygen
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4 to 20 mA, current regulated to drive any load between 0 and 550 ohms at 24 V dc.
Process Connection:	Immersion in process fluid
Classification:	NEMA 4 enclosure
Description:	Dissolved oxygen measuring unit shall consist of a Galvanic cell (probe) immersed in the process, a field mounted calibration unit located near the probe, and a remotely mounted indicating analyzer. The probe shall contain a motorized cleaning mechanism that continuously scrapes the electrodes during operation. The probe electrodes shall be mounted by suspension in a vertically reinforced standoff bracket provided by the manufacturer. The calibration unit shall contain a 4-1/2 inch dual-scale (0-5, 0-10 PPM) meter calibrated in process units and be housed in a NEMA 4 enclosure. The calibration unit shall be connected to the probe via a weather proof cable and quick disconnect plug/jack assembly at the probe. The analyzer shall be panel mounted with a dual-scale 4-1/2 inch panel meter. The analyzer shall be equipped with two switch selectable ranges (0-5, 0-10 PPM) and generate an isolated 4 to 20 mA dc signal linearly proportional to the measured DO over the range selected.
Manufacturer(s):	Zullig Model 76, Great Lakes Instruments, Inc., or approved equal.
Special Requirements:	The analyzer shall be powered by 120 V ac and provide all power required by the calibration unit and the probe via the manufacturer supplied cables interconnecting the three units.

3.2.02 Turbidity surface Scatter.

Instrument Category:	Analyzers
Instrument Type:	Turbidity Surface Scatter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	Selectable for 0-10 mV, 0-100 mV, 0-1V or 4-20 mA. Output span programmable over any portion of range.
Process Connection:	3/4 inch NPT, Sample, 3/4 inch NPT Drain, 1 inch NPT Overflow
Classification:	NEMA 12 Clear Industrial Plastic Enclosure
Description:	The Turbidimeter shall be a continuous-reading, on-line instrument using the nephelometric method of measurement. It shall be an EPA-Approved design utilizing a single silicon photodiode to detect 90 degrees side-scattered light. An auto-ranging digital display shall read from 0-9999 NTU. Accuracy shall be better than $\pm$5 percent from 0-2000 NTU and $\pm$10 percent from 2000-9999 NTU. Resolution shall be 0.01 NTU. Calibration shall be based on formazin, the primary turbidity standard. The Turbidimeter shall consist of two main component parts: a sample unit and a control unit.

All optical and hydraulic components shall be housed in the sample unit. The light source shall be directed on the surface of the water sample, eliminating the use of a glass window or flow cell. The sample unit shall be constructed of corrosion-resistant structural plastic. It shall be powered from the control unit and require no separate power source.

The control unit shall provide a digital LED display with four digits and automatic decimal positioning. The control unit also shall provide a linear output signal that can be programmed to span all, or any portion, of the 0-9999 NTU range.

A bubble reject circuit shall be provided to eliminate

	spikes in measurement due to transient sample conditions. Self-test diagnostics shall be provided to automatically indicate possible instrument malfunctions.
Manufacturer(s):	HACH Company Surface Scatter Turbidimeter, no equal.
Special Requirements:	Wall Mount

3.2.03 Chlorine.

Instrument Category:	Analyzers
Instrument Type:	Chlorine
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	Selectable 0-10 mV, 0-100 mV, 0-1 V, or 4-20 mA. Output span programmable over any portion of range.
Process Connection:	1/8 inch NPT Sample, 3/4 inch NPT drain
Classification:	NEMA 12 Clear Industrial Plastic Case
Description:	The Chlorine analyzer shall be a continuous reading on-line microprocessor based analyzer capable of measuring free or total residual chlorine in the range of 0 to 5 mg/l and producing an output proportional to the sample concentration of chlorine. The analysis method used shall be DPD colorimetric method. Accuracy shall be better than ±5 percent of reading or ±0.04 mg/l with a resolution of 0.01 mg/l, a repeatability of ±0.05 mg/l and a response time of 90 percent in two minutes, 100 percent in four minutes. The control unit shall provide a 3-digit LED display in mg/l.
Manufacturer(s):	HACH Company, Model CL 17, Capital Controls or approved equal.
Special Requirements:	Wall Mount

3.2.04 pH Transmitter and pH Probe.

Instrument Category:	Analyzers
Instrument Type:	pH Transmitter and pH probe
Power Supply:	120 V ac, 60 Hz
Signal Output:	4-20 mA into 1000 ohms max, 2 DPDT setpoint relays
Process Connection:	3/4 inch FNPT Inlet and Outlet
Classification:	NEMA 4X
Description:	The pH transmitter shall be a microprocessor based unit capable of receiving a signal from a compatible probe and indicating pH in a range of 0 to 14. The transmitter shall provide a 4 digit LED display that gives a selectable indication of pH, maximum reading, minimum reading, average reading, setpoint levels, and temperature. LED indicators shall display the selected mode. The unit shall be capable of calculating, storing, and displaying the minimum, maximum, and average pH reading over the previous 24 hours. All display, function and power switches shall be located on the front panel. The unit shall be housed in a NEMA 4X enclosure and shall be supplied with a signal conditioning pre-amp compatible with the specified pH probe. The pH element shall be comprised of a double junction electrode with temperature compensation, and a CPVC flow through mounting cell. The element shall be of a flat surface design, having no protruding glass bulbs, and shall incorporate both the measuring and reference electrodes built into a single CPVC body. The unit shall be supplied with 15 feet of cable for connection to a signal conditioning pre-amp.
Manufacturer:	Rosemount, Capital Controls Co. Series 9410, or approved equal

3.2.05 pH Element (Flow).

Instrument Category:	Analyzers
Instrument Type:	pH Element (Flow)
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	Compatible with pH transmitter
Process Connection:	3/4 inch FNPT Inlet and Outlet
Classification:	NEMA 4X
Description:	The pH element shall be comprised of a double junction electrode with temperature compensation, and a CPVC flow through mounting cell. The element shall be of a flat surface design, having no protruding glass bulbs, and shall incorporate both the measuring and reference electrodes built into a single CPVC body. The unit shall be supplied with 15 feet of cable for connection to a signal conditioning pre-amp.
Manufacturer:	Rosemount**,** Capital Controls Co. model #R-3973, or approved equal
Special Requirements:	To assure compatibility the pH element shall be supplied with a Capital Controls series 9410 pH indicator/transmitter, as described in Instrument Specification Sheet 17540-1.11 or respective Rosemount transmitter if Rosemount is used.

3.2.06 Chlorine Multipoint Detector/Alarm.

Instrument Category:	Analyzers
Instrument Type:	Chlorine Multipoint Detector/Alarm
Power Supply:	120 V ac, 60 Hz
Signal Input:	4-20 mA
Signal Output:	4-20 mA; 2 SPDT or 1 DPDT (user selectable) alarm relays.
Process Connection:	N/A
Classification:	NEMA 4X
Description:	The Gas Detector shall consist of one to eight sensors and one receiver. The sensor(s) shall be of a sealed solid state, electrochemical, micro-redox design, and shall be housed in a wall mounted NEMA 4X enclosure. The sensor shall receive a 18-24 V dc signal, generate 4-20 mA dc in proportion to chlorine level, provide 80 percent response in less than 30 seconds, and recover to 90 percent in less than 3 minutes. Minimum detectable concentration shall be 0.5 ppm, with an operating temperature range of -2°F to 131°F, and a maximum sensor to receiver separation of 1000 feet. The receiver shall process and display signals from 1 to 8 sensors, shall be housed in a NEMA 4X enclosure, and shall contain the following components: a power switch; LED indicators for power, ready, setpoint level, alarm level, alarm status, and malfunction; pushbutton controls for setpoint level, alarm acknowledge, alarm reset, and auto and manual scan; and an LED digital indication of sensor being scanned. The receiver shall produce a 4-20 mA signal proportional to scanned levels, and shall provide a relay contact closure when the gas level exceeds the setpoint or if a sensor malfunction occurs. Sensor scanning rate shall be adjustable via movable jumpers.
Manufacturer:	Capital Controls Co Model 1620B, Wallace & Tiernan, or approved equal.

3.2.07 Density (Solids) Indicating Transmitter.

Instrument Category:	Analytical
Instrument Type:	Density (Solids) Indicating Transmitter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA into 600 ohm max. load
Process Connection:	N/A
Classification:	NEMA 4X
Description:	The purpose of this instrument is to detect and track a sludge blanket level in a tank. The unit shall consist of an electronic control unit, measuring probe, drive mechanism and cable spool assembly. The detection method shall be a four beam, infrared sensor designed to measure the suspended solids concentration. The instrument shall track blanket depth by comparing the concentration at the probe position to an operator-adjustable concentration setpoint. The probe shall be automatically raised or lowered based on difference between setpoint and measured value until the setpoint concentration is detected. A 4-20 mA output signal shall be generated proportional to the depth at which the setpoint concentration is detected. The position of the probe shall be controlled by an AC motor driving the cable spool. The DC motor, measurement and control circuitry shall be housed in a NEMA 4X enclosure. The spool shall be constructed of PVC with a polyurethane painted steel frame. The unit shall have a digital display of level for a minimum span of 0-10 meters and an accuracy of $\pm$0.5 percent for a solids concentration of 0.1-10 g/l with auto compensation for build-up on probe.
Manufacturer:	BTG Polymetron Model SLM-3000, no equal.
Special	Units used in clarifiers with moving collector arms

Requirements:	shall have circuity that retracts the probe and holds reading during retraction. Action shall be switch initiated.

3.2.08 Combustible Toxic Gas Detector.

Instrument Category:	Analytical
Instrument Type:	Combustible Toxic Gas Detector
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 MA
Process Connection:	N/A
Classification:	Sensor shall be suitable for NEMA 7, Division 1, Class 1, Groups A, B, C, D. Transmitter shall be suitable for Class 1, Division. 1, Groups B, C, D, and Class II, Groups E, F & G. NEMA 4X Dust Tight and Water Tight.
Description:	Detector consists of a solid-state monitor and depending on the gas/application an infrared or an electrochemical gas sensor. Where alarm relays are required, Provide High, Low, and Failure relays. Setpoints of alarm relays shall be field adjustable. Provide a transmitter with an eight character alphanumeric LCD display. The Transmitter display shall indicate the following; power on status, gas concentration, alarm and fault conditions. Detector ambient operating temperature range shall be -40° to 75°C. Sensor shall be specific to the gas/condition being monitored. Two types of sensor will be acceptable. Provide Infrared sensor for Hydrocarbon gas detector. Provide Electrochemical sensor for Hydrogen Sulfide, Oxygen, Carbon Monoxide, Sulfur Dioxide, and oxides of Nitrogen. Infrared sensor shall be temperature stable over a range of -40° to 75°C. The Infrared sensor shall operate over a range of 0 to 99 percent relative humidity. Sensor housing shall be manufactured of a material

	suitable for the atmosphere in which it is installed. Where electrochemical sensors are to be used, provide electrochemical sensors that are specific to the gas being sensed. Provide electrochemical sensors that are suitable for operation in temperatures of -20° to 50°C.
Manufacturer:	Det Tronics, MSA or approved equal.
Special Requirements:	The Contractor shall wire so as to “gang” alarm output to provide single relay contact closure depicting a unified alarm condition on any area. The Contractor is responsible for determining sensor application type and front panel display calibration. Provide sensor to meet area classification as required for each location.

3.2.09 <u>Density (Solids) Indicating Transmitter</u>.

Instrument Category:	Analytical
Instrument Type:	Density (Solids) Indicating Transmitter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA into 600 ohm Max load
Process Connection:	N/A
Classification:	NEMA 4X
Description:	The unit shall determine solids concentration by measuring backscattered light from a pulsed, infrared LED source. Measuring range shall be 0.5 percent to 10 percent sludge density. Minimum accuracy shall be 2 percent of instrument span. The unit shall consist of a sensing element (see Instrument Specification Sheet 17540 1.18) and transmitter. The transmitter shall be front panel configurable via integrated keypad and LCD information display. Configuration and calibration shall be retained in non-volatile memory.
Manufacturer:	BTG Polymetron, Model HCT-3000, no equal.

Special Requirements:	Some locations will require enclosures and fittings designed for installation and operation in classified areas - rating for each area to be determined.

3.2.10 Density (Solids) Measuring Probe.

Instrument Category:	Analytical
Instrument Type:	Density (Solids) Measuring Probe
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	Compatible with BTG Model HCT-3000 density indicating transmitter (Instrument Specification Sheet 17540 1.17)
Process Connection:	2 inch NPT
Classification:	NEMA 4X w/316 stainless steel Fittings
Description:	Fiber optic sensor with special extraction assembly for ease of sensor replacement and cleaning. Model to interface with HCT-3000 transmitter.
Manufacturer:	BTG Polymetron HC-300, no equal
Special Requirements:	Probe sensitivity to be selected for each application based on sludge concentration, subject to review by the Contracting Officer. Design for installation and operation in classified areas - area rating to be determined.

3.2.11 Conductivity Analyzer.

Instrument Category:	Analytical
Instrument Type:	Conductivity Analyzer
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA into 1000 ohms max, 2 DPDT setpoint relays

Process Connection:	N/A
Classification:	NEMA 4X
Description:	The conductivity transmitter shall be a microprocessor based unit capable of receiving a signal from a compatible probe and indicating conductivity in selectable ranges of 1-10 or 10-100 uS/cm, or 0.1-1, 1-10 or 10-100 mS/cm. The transmitter shall provide a 4 digit LED display that gives a selectable indication of conductivity, maximum reading, minimum reading, average reading, and setpoint levels. LED indicators shall display the selected mode. The unit shall be capable of calculating, storing, and displaying the minimum, maximum, and average conductivity reading over the previous 24 hours. All display, function and power switches shall be located on the front panel. The unit shall be housed in a NEMA 4X enclosure and shall be supplied with a compatible conductivity probe.
Manufacturer:	Rosemount**,** Capital Controls Co. Series 9510, Great Lakes, or approved equal
Special Requirements:	The Contractor shall be responsible for proper placement of conductivity cell.

End of Section

SECTION 17550

MISCELLANEOUS INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of instrumentation equipment required for Master Specification Section 17100, Computer Control System, as indicated on the drawings and as required.

Principal components of the instrumentation systems shall be as indicated on the P&ID drawings; as indicated on the instrument device schedule drawings; as indicated on the instrument device schedules attached to Master Specification Section 17500, Instrumentation General Requirements, or as required.

1.2 GENERAL. Contractor shall select the equipment furnished under this section for its superior quality and the intended performance. An Installation Contractor will install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the requirements specified in Master Specification Section 17500, Instrumentation General Requirements.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

PART 2 - PRODUCTS

2.1 INDIVIDUAL DEVICE SPECIFICATIONS. Individual instruments and related devices shall be provided as specified in the Contract Documents, and as required.

PART 3 - EXECUTION

3.1 INSTRUMENTATION INSTALLATION REQUIREMENTS. Instrumentation installation requirements shall be as specified in Master Specification Section 17500, Instrumentation General Requirements.

3.2 MISCELLANEOUS INSTRUMENT SPECIFICATIONS. The following miscellaneous instrument specifications shall be followed:

3.2.01 Low Range Tachometer.

Instrument Category:	Speed
Instrument Type:	Low Range Tachometer
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	Drive Shaft
Classification:	NEMA 4
Description:	Sensing heads shall be mounted near motor shaft. The sensor body material shall be constructed from aluminum, and provided with a steel mounting bracket. The sensor shall be supplied with an integral three wire shielded conductor. The sensors shall be capable of monitoring speeds as low as 0.1 RPM. All incoming sensor leads shall be wired into terminal strips located on the signal conditioner in a wall mounted enclosure. The electronics shall provide 4-20 mA and 0-10 V dc out proportional to shaft speed. Located on the front of the enclosure shall be a digital indicator to indicate the shaft speed. Mounted on each shaft shall be a pulsar disk constructed of PVC with sixteen magnets. The disk shall mount on the shaft end and the disk shall be 1/2 inch (12.7 mm) thick.
Manufacturer:	Electro-Sensors Model 960 sensor head and standard disk with DSC-10C signal conditioner or approved equal.
Special Requirements:	The Contractor is responsible for verifying the shaft diameter.

3.2.02 Variable Speed Shaft Monitoring Transmitter.

Instrument Category:	Speed
Instrument Type:	Variable speed shaft monitoring transmitter
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	Drive Shaft
Classification:	NEMA 4 and 12
Description:	The variable speed shaft monitoring transmitter shall consist of the sensor, electronics, and pulsar wrap. The sensing head shall be mounted near each motor shaft. The sensor body material shall be constructed from aluminum and provided with a steel mounting bracket. Each sensor shall be supplied with an integral three wire shielded conductor. The electronics shall be mounted in a NEMA 12 enclosures. The incoming sensor leads shall be wired into terminal strips located in the enclosure. The electronics shall provide an output proportional to the speed. The system shall be adjustable for ranges from 20-7500 RPM. Mounted on to each shaft shall be a pulsar wrap constructed of Aluminum with sixteen magnets.
Manufacturer:	Electro-Sensors, Model DSC10CA or approved equal
Special Requirements:	The Contractor is responsible for verifying the exact shaft diameter.

3.2.03 Shaft Reverse Detector.

Instrument Category:	Speed
Instrument Type:	Shaft Reverse Detector
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	SPDT 5A Relay
Process Connection:	Pump Shaft (See Special Requirements)
Classification:	NEMA 4
Description:	The Shaft Reversal Detector shall consist of the sensor, electronics, and pickup. The sensor shall be mounted near the shaft. The sensor/electronics shall be housed in a stainless steel housing and provide an alarm condition upon not more than 1 complete reverse shaft rotation. The mounting bracket shall be constructed of stainless steel. Electrical connection to sensor/electronics shall be hand spliced with 12 inch (30.5 cm) min lead length and connected via flexible conduit to a terminal junction box. The pickup shall be mounted on the shaft. The range of operation shall be 0-5000 RPM. The construction material shall be PVC or stainless steel with operating temperature -104°F to 140°F (40°C to +60°C).
Manufacturer:	Electro-Sensors Model D100, Airpax-Tachtrol-3 or approved equal.
Special Requirements:	The Contractor is responsible for verifying the exact shaft diameter.

3.2.04 Indicating Transmitter.

Instrument Category:	Temperature
Instrument Type:	Indicating Transmitter

Power Supply:	24 V dc
Signal Input:	RTD, 200 ohm Max.
Signal Output:	4-20 mA
Process Connection:	Three-Wire, screw terminals
Classification:	NEMA 4X
Description:	Transmitter shall be manufactured using a zinc alloy condulet. The span and zero shall be field selectable. The span shall be as narrow as 180°F (100°C) to as wide as 1710°F (950°C) located between 392°F (-200°C) and 1562°F (850°C) DIN maximum of RTD's. Repeatability shall be at least ±0.4°F (±0.2°C) ±0.1 percent of span. Indicator shall be at least a 3-1/2 digit LCD integral to the transmitter housing (see special requirements. Operating range shall be -40°F to 185°F (-40°C to 85°C), 0-100 percent RH.
Manufacturer:	Wilkerson Instrument Company Inc., Model TW8300, or approved equal.
Special Requirements:	N/A

3.2.05 RTD.

Instrument Category:	Temperature
Instrument Type:	RTD
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	Thermowell-Epoxied-Screwed Eyelet
Classification:	N/A
Description:	RTD shall be a three-wire type with separate ground connection, made of platinum with a 100 ohm resistance at 25°C. The accuracy shall be at

	least ±0.1 percent. The range shall be 355°F to 500°F (-215°C to 260°C) with a repeatability of 0.2°F (0.1°C) after ten cycles over full temperature range. Insulation resistance from element to sheath shall be at least 100 megohms at 50 percent RH, 68°F (20°C), 100 V dc.
Manufacturer:	GIC Thermodynamics Inc. or approved equal.
Special Requirements:	The Contractor shall determine type of RTD connection to be used in each application. Consideration shall be given to expected in-service conditions.

3.2.06 Temperature Switch.

Instrument Category:	Temperature
Instrument Type:	Temperature Switch
Power Supply:	24 V dc
Signal Input:	0°F to 100°F (18°C to 38°C)
Signal Output:	4-20 mA
Process Connection:	1/2 inch NPT
Classification:	NEMA 4X
Description:	Provide field mounted temperature transmitter with integral indicator scaled in engineering units. The transmitter measuring element shall be a thermocouple or RTD dependent on measured variable range the element shall be enclosed in 316 stainless steel probe. The probe shall be isolated from the process by a 316 stainless steel thermowell. Transmitter shall have an accuracy/repeatability of ±0.2 percent. The electronics and indicator shall be removable modular type with zero and span adjustment.
Manufacturer:	United Electric, Automatic Switch Company (ASCO), S.O.R., Tripoint or approved equal.
Special Requirements:	The Contractor shall select proper range and mounting style to fit application. Bulb type units

shall use a thermowell of material compatible with process fluid. The Contractor shall determine insertion depth of well. Connection of bulb to well shall be 1/2 inch (1.3 cm) NPT. Connection of well to process shall be 3/4 inch (1.9 cm) NPT.

3.2.07 Temperature Transmitter.

Instrument Category:	Temperature
Instrument Type:	Temperature Transmitter
Power Supply:	24 V dc
Signal Input:	Thermocouple or RTD
Signal Output:	4-20 mA Linearized
Process Connection:	N/A
Classification:	NEMA 4X, NEMA 7
Description:	Temperature transmitter for converting a thermocouple or RTD signal to a proportional, linearized 4-20 mA Signal. Load at 24 V dc = 600 ohms. Accuracy $\pm$0.1 percent of span or better. Minimum input/output isolation = 600 V ac rms. Minimum isolation to ground 1000 V dc. Common mode rejection 120 dB min., DC-60Hz. Normal mode rejection 60 dB min. at 50/60 Hz. Ambient temperature range -40°F to 185°F) -40°C to 85°C. Temperature effect $\pm$0.01 percent of span/°F ($\pm$0.02 percent of span/°C). RFI protection shall meet SAMA standard PMC 33.1C, less than 0.5 percent of span at 10V/meter.
Manufacturer:	Rosemount, SMAR**,** Newport series 500, Transmation series 2800, Rochester Instrument Systems SC43000 series or approved equal.
Special Requirements:	Any unit applied in an area classified hazardous shall be supplied in an explosion proof enclosure.

3.2.08 Indicating Transmitter.

Instrument Category:	Temperature

Instrument Type:	Indicating Transmitter
Power Supply:	24 V dc
Signal Input:	RTD or Thermocouple
Signal Output:	4-20 mA
Process Connection:	3/4 inch NPT
Classification:	NEMA 4,7
Description:	Provide temperature system assembly that includes thermowell, RTD or thermocouple, transmitter and indicator in an integrally housed unit. Thermowell shall be standard duty straight thermowell constructed of 316SS. RTD shall be 2 wire, 100 ohm platinum sensor, spring loaded. Transmitter shall be loop powered, condolet styled providing linear 4-20 mA output accurate to 0.05 percent of span with accessible non-interacting zero and span calibration. Indicator shall be 3-1/2 active digit LCD display with field selectable scaling in appropriate engineering units.
Manufacturer:	Rosemount, SMAR**,** Moore Industries, Foxboro, or approved equal
Special Requirements:	The Contractor shall determine enclosure classification requirements and provide enclosure for required application. The Contractor shall be responsible for determining insertion length for each individual application.

3.2.09 Thermocouple Assembly.

Instrument Category:	Temperature
Instrument Type:	Thermocouple Assembly

Power Supply:	N/A
Signal Input:	N/A
Signal Output:	Millivoltage (against Std. reference junction) for type J, K, T, S per IPTS 68 calibrations
Process Connection:	1/2 inch (1.3 cm) NPT T/C assembly; 3/4 inch (1.9 cm) for thermowell
Classification:	General Purpose
Description:	Temperature element shall consist of type (J,K,T,S) consistent with application. Element shall be encased in magnesium oxide within a 1/4 inch (63 mm) swaged 316 stainless steel sheath. A 1/2 inch x 1/2 inch (1.3 x 1.3 cm) NPT nipple shall be affixed and sealed to upper end of sheath. Junction shall be ungrounded. Assembly shall be affixed to an aluminum or cast iron head complete with terminal strip and screw on cover. Cover shall be chained to head. A 3/4 inch (1.9 cm) NPT conduit opening shall be provided. Assemblies for use with thermowells shall be spring loaded to ensure positive contact between T/C element and thermowell.
Manufacturer:	Thermoelectric, GIC Thermodynamics or approved equal
Special Requirements:	The Contractor shall correctly size length of element, lagging fittings, and thermowell as required. Sheath and well material must be compatible with process fluid. Mechanical mounting and protection of directly inserted element, as necessary, shall be provided by the Contractor. Thermowell shall be provided where process cannot be shutdown to change thermocouple assembly, (e.g. tanks, filled pipes, etc.). Thermowell shall be spun or turned bar stock tapered from threaded end to tip. It shall accept 1/4 inch (63 mm) swaged element. Thermocouple assembly connection shall be 1/2 inch (1.3 cm) NPT. Process connection shall be 3/4 inch (1.9 cm) NPT with HEX wrench head.

3.2.10 RTD Assembly, 3 Wire.

Instrument Category:	Temperature
Instrument Type:	RTD Assembly, 3 wire configuration
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	Platinum resistance element calibrated to International Resistance vs. Temperature curve (DIN 43760); 100 ohm at 0°C.
Process Connection:	1/2 inch NPT RTD assembly; 3/4 inch NPT for thermowell
Classification:	General Purpose
Description:	Temperature element shall be a 100 ohm at 32°F (0°C) RTD. Element shall be encased in magnesium oxide within a 1/4 inch (63 mm) swaged 316 stainless steel sheath. A 1/2 inch x 1/2 inch (1.3 cm x 1.3 cm) NPT nipple shall be affixed and sealed to upper end of sheath. Element shall not contact sheath. Assembly shall be affixed to an aluminum or cast iron head complete with terminal strip and screw on cover. Cover shall be chained to head. A 3/4 inch (1.9 cm) NPT conduit opening shall be provided. Assemblies for use with thermowells shall be spring loaded to ensure positive contact between RTD element and thermowell.
Manufacturer:	Thermoelectric, GIC Thermodynamics or approved equal
Special Requirements:	The Contractor shall correctly size length of element, lagging fittings, and thermowell as required. Sheath and well material must be compatible with process fluid. Mechanical mounting and protection of directly inserted element, as necessary, shall be provided by the Contractor. Thermowell shall be provided where process cannot be shutdown to change RTD assembly, (e.g. tanks, filled pipes, etc.).

Thermowell shall be spun or turned bar stock tapered from threaded end to tip. It shall accept 1/4 inch (63 mm) swaged element. RTD assembly connection shall be 1/2 inch (1.3 cm) NPT. Process connection shall be 3/4 inch (1.9 cm) NPT with HEX wrench head.

3.2.11 Pinch Valve.

Instrument Category:	Valves
Instrument Type:	Pinch Valve
Power Supply:	120 V ac, 60 Hz
Signal Input:	4-20 mA
Signal Output:	N/A
Process Connection:	2 inch NPT
Classification:	N/A
Description:	Pinch valve shall employ electrically actuated control with input from a single loop controller. Valve shall be constructed of cast iron, ANSI 125. Sleeves shall be a material selected to be compatible with controlled media. An equal percent cam shall be employed in order to provide near linear control over the entire valve operating range. Positioner shall employ true feedback for accuracy. Position indicator will be provided. Limitorque or Rotork actuators will be used.
Manufacturer:	Red Valve or approved equal.
Special Requirements:	The Contractor is responsible for selecting sleeve material according to expected service conditions. The Contractor shall determine correct valve sizing for proper control in the specified application.

3.2.12 Weir Valve.

Instrument Category:	Valves
Instrument Type:	Weir Valve

Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	150 psi flanged (ANSI)
Classification:	N/A
Description:	Valve shall be weir type diaphragm, electrically actuated for on/off control. Position switches shall provide positive indication of completely closed or open status of valve. Control solenoid(s) are to be part of the furnished valve assembly. The pneumatic actuator shall be configurable for either fail open or fail closed operation. Actuator shall operate from 60 psig minimum air supply. Body of valve shall be glass reinforced, chemical resistant PVC. Diaphragm shall be chemical resistant TFE. Bonnet shall be sliding stem type compatible with the specific pneumatic actuator used. Valve assembly shall be delivered fully assembled and tested.
Manufacturer(s):	Saunders Valves, Inc. or approved equal.
Special Requirements:	The Contractor shall be responsible for selecting the proper sizing to fit the application and flow conditions. The Contractor is also responsible for ensuring correct material is chosen for chemical compatibility.

3.2.13 Butterfly Valve.

Instrument Category:	Valves
Instrument Type:	Butterfly Valve
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	150 psi flanged (ANSI)

Classification:	N/A
Description:	Valve shall be resilient seated butterfly valve for wastewater applications, electrically actuated for on/off control. Position switches shall provide positive indication of completely closed or open status of valve. Control solenoid(s) are to be part of the furnished valve assembly. The pneumatic actuator shall be configurable for either fail open or fail closed operation. Actuator shall operate from 60 psig minimum air supply. Valve body shall be cast with Epoxy coating for corrosion resistance. Wetted metal parts shall be 316 stainless steel. Valve assembly shall be delivered fully assembled and tested.
Manufacturer(s):	DeZurik, Keystone, Bray or approved equal.
Special Requirements:	The Contractor shall be responsible for selecting the correct valve size and actuator configuration for the application and flow conditions.

3.2.14 Solenoid Valve.

Instrument Category:	Valve
Instrument Type:	Solenoid Valve
Power Supply:	120 V ac, 60 Hz, 24/125 V dc
Signal Input:	N/A
Signal Output:	N/A
Process Connection:	As directed per drawings
Classification:	See Description
Description:	Solenoid shall be two way, three way or four way with piped exhaust for pipe or tubing size 1/4 inch (6.3 cm) through 2 inch (5 cm), and have Teflon seats with zero leakage. Coil operation shall be 125 V dc/120 V ac, 60Hz, Class H molded type. Panel mounted valves shall be open frame, spade terminal type. Field mounted valves for non hazardous areas shall be housed in NEMA 4x

	enclosures with not less than 18 inch (30 cm) leads. Field mounted valves in hazardous areas shall be housed in NEMA 7 enclosures with not less than 18 inch (30 cm) leads.
Manufacturer:	Automatic Switch Company, Inc. (ASCO) Red Hat, Magnetrol International, Honeywell Skinner or approved equal.
Special Requirements:	The Contractor shall determine 2, 3, or 4 way operation to provide proper operational function as per drawings, and schedules. The Contractor shall determine required coil operating voltage from existing electrical drawings. The Contractor shall make all necessary alterations to existing piping or tubing to assure correct installation and operation of the new solenoid valves.

3.2.15 Potentiometric Position Transmitter.

Instrument Category:	Miscellaneous
Instrument Type:	Potentiometric Position Transmitter
Power Supply:	12-60 V dc
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	As specified on drawings
Classification:	NEMA 4X
Description:	This two-wire transmitter shall be a rotary position transmitter enclosed in a watertight, industrial type enclosure. Unit shall be capable of 1/4 minimum to 104 maximum input turns for a proportional 4-20 mA output, with built in zero and span adjustments. Output linearity shall be within 0.5 percent full scale unit shall have optional SPDT switches when specified by drawings or application. Ambient operating temperature range shall be 32°F to 126°F (0°C to 52°C).
Manufacturer:	Jordan or approved equal.

Special Requirements:	The Contractor is required to specify input turns for each application.

3.2.16 Chlorine Container Scale.

Instrument Category:	Miscellaneous
Instrument Type:	Chlorine Container Scale
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	NEMA 4X (Display)
Description:	The scales shall be designed specifically for chlorine use, and shall incorporate electronic, stainless steel, shear beam load cells with shock isolators and overload stops. The frame shall be constructed from cold rolled steel and be coated with an acrylic urethane enamel finish. The scale shall have a low profile design, shall use integral roller trunnions, and shall have no other moving parts such as pivots or bearings. The display shall be a microprocessor based digital unit, capable of displaying gross, net and tare weights. All display functions shall be accessible from the front panel of the display. The display unit shall have RFI/EMI filtering, and provide 4-20 mA output proportional to weight.
Manufacturer:	Scale: Eagle Microsystems model C3600P, Display- Eagle Microsystems model UMC555 or equal product by Force Flow Equipment company.
Special Requirements:	To ensure compatibility, the Contractor shall ensure that the scale and display are provided by the same manufacturer.

3.2.17 Vibration Transmitter/Switch.

Instrument Category:	Miscellaneous
Instrument Type:	Vibration Transmitter/Switch
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA, and Dual Trip Switches
Process Connection:	3-1/4 inch-inch Mounting Holes
Classification:	Explosion Proof or NEMA 4X
Description:	The vibration unit shall utilize a solid state crystal that provides a 4-20 mA analog output proportional to the vibration. The unit shall also have dual trip switches for vibration alarm and trip. The unit shall have an accuracy of $\pm$10 percent with a repeatability of $\pm$2 percent. Provisions for self-test and calibration shall be provided.
Manufacturer:	Bently Nevada, PMC/BETA Model 440D-R, or approved equal.
Special Requirements:	N/A

3.2.18 Loop Signal Conditioner (Current Trip).

Instrument Category:	Miscellaneous
Instrument Type:	Loop Signal Conditioner (Current Trip)
Power Supply:	24 V dc
Signal Input:	4-20 mA
Signal Output:	Two SPDT Contacts (3 AMP Rating)
Process Connection:	N/A
Classification:	NEMA 1
Description:	The device shall be a rack mounted, current alarm, dual trip with LED alarm setpoint display and trip indication. The unit shall have a repeatability and

	deadband of 0.05 percent with upscale/downscale burn out. The operating range shall be 0°F to 140°F (-17.8°C to 60°C).
Manufacturer:	AGM, Rochester Instrument Systems (RIS), Adtech, Acromag or approved equal.
Special Requirements:	N/A

3.2.19 Proximity Switch.

Instrument Category:	Miscellaneous
Instrument Type:	Proximity Switch
Power Supply:	N/A
Signal Input:	N/A
Signal Output:	SPDT Form C Contacts 125w
Process Connection:	N/A
Classification:	Explosion Proof or NEMA 4X
Description:	The Proximity Switch shall be a magnetically actuated device housed in a 304 stainless steel enclosure. The sensing range shall be not more than 0.562 inch (14.3 mm) with 0.002 inch (0.05 mm) repeatability. The response time shall not exceed 8 ms. The ambient temperature operating range shall be -40°F to 205° F (-40°C to 121°C). Contacts shall be environmentally sealed.
Manufacturer(s):	General Equipment Manufacturers, Go Switch Series, no equal.
Special Requirements:	N/A

3.2.20 Loop Signal Conditioner (I/P).

Instrument Category:	Miscellaneous
Instrument Type:	Loop Signal Conditioner (I/P)

Power Supply:	24 V dc
Signal Input:	4-20 mA
Signal Output:	3-15 psi (0.21 to 1.05 kg/cm^2)
Process Connection:	N/A
Classification:	NEMA 1
Description:	The device shall be a rack mounted transducer with adjustable zero and span and a repeatability/deadband of 0.05 percent with upscale/downscale burn out. The ambient temperature tolerance shall be 0°F to 140°F (-17.8°C to 60°C).
Manufacturer:	Brandt, Rochester Instrument Systems (RIS), Moore Industries, or approved equal
Special Requirements:	N/A

3.2.21 Loop Signal Conditioner (R/I).

Instrument Category:	Miscellaneous
Instrument Type:	Loop Signal Conditioner (R/I)
Power Supply:	24 V dc
Signal Input:	0-1000/2000/5000 or 10,000 ohms
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	NEMA 1
Description:	The device shall be a rack mounted transducer with adjustable zero and span and a repeatability/deadband of 0.05 percent with upscale/downscale burn out. The ambient temperature tolerance shall be 0°F to 140°F (-17.8°C to 60°C).

Manufacturer:	AGM, Rochester Instrument Systems (RIS), Adtech, Acromag or approved equal.
Special Requirements:	N/A

3.2.22 Limit/Proximity Switch.

Instrument Category:	Miscellaneous
Instrument Type:	Limit/Proximity Switch
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	500 mA, Reed
Process Connection:	N/A
Classification:	NEMA 12
Description:	Limit switch shall be a 2 piece, magnetic reed operated device to provide a dry contact for sensing door/window open/close application. Ambient temperature operating range shall be -13°F to 185°F (-25°C to 85°C).
Manufacturer:	General Equipment Manufacturers, Go Switch Series, Microswitch, Square "D", Cutler-Hammer, or approved equal.
Special Requirements:	N/A

3.2.23 Humidity/Temperature.

Instrument Category:	Miscellaneous
Instrument Type:	Humidity/Temperature
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	4-20 mA

Process Connection:	N/A
Classification:	NEMA 4
Description:	Unit shall measure both humidity and temperature. Measuring range shall be 0-100 percent relative humidity with ±2 percent relative humidity accuracy over the range of 0 to 90 percent relative humidity, and ±3 percent accuracy over the range of 90 to 100 percent relative humidity at 68°F (20°C), and shall have a 90 percent response within 15 seconds. Linearity shall be better than 0.2°F (0.1°C). The unit shall be housed in an industrial type enclosure suitable for rugged environments. Ambient operating temperature range shall be -4°F to 176°F (-20° to 80°C).
Manufacturer:	Vaisala Model HMD 20/u/HMP 111 A, or approved equal.
Special Requirements:	The Contractor shall provide manufacturer approved field calibrator.

3.2.24 Weather Station.

Instrument Category:	Miscellaneous
Instrument Type:	Weather Station
Power Supply:	120 V ac, 60 Hz
Signal Input:	N/A
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	NEMA 4X

Description: The weather station shall be a complete weather monitoring system capable of measuring wind speed, wind direction, temperature, relative humidity and precipitation. The station shall be composed of sensors and electronic translator modules that provide accurate and reliable data. The translator modules shall have precise zero and span adjustments and shall output 4-20 mA for each sensor. The sensors shall have the following accuracy after conversion through the translator:

Measurement:	**Accuracy:**
Wind Direction	3°
Wind Speed	0.5 mph
Temperature	0.5°F
Relative Humidity	20 to 100 percent
Rainfall	0.01 inch or 1 percent
Barometric Pressure	±5 percent of Full Scale

Manufacturer: Met One or approved equal.

Special Requirements: N/A

The following sensors shall be provided as part of the weather station:

Wind Direction: Wind direction shall be measured with a lightweight air-foil vane and a micro-torque potentiometer. The wind direction translator shall eliminate the 0/360 degrees crossover transition by offsetting the transition when it occurs.

Wind Speed: Wind Speed shall be measured with a rotating three-cup anemometer that operates a magnetic reed switch. The translator module shall convert the switch pulses into a 4-20 mA signal representing wind speed from 0 to 100 mph. The anemometer shall be mounted on a 5 feet wing instrument arm.

Temperature: A three-element linear thermistor shall measure temperature. The sensor shall be housed in a vane aspirated radiation shield. The sensor shall measure temperature from –40° to + 120°F.

Relative Humidity: Relative humidity shall be sensed with a solid-state capacitor. A radiation shield shall be provided to house the sensor.

Precipitation: Precipitation shall be measured with a tipping-bucket rain gauge. The gauge shall tip for every 0.01 inch of rainfall. The rain gauge shall be heated for use at below freezing temperatures for measuring snowfall.

Barometric Pressure: Barometric Pressure shall be measured in inches of mercury. The sensor shall be temperature compensated.

Tower: All sensors shall be mounted per manufacturer's instructions on a tower designed for weather station instruments. Translators and power supply shall be mounted in a weatherproof cabinet. Power source shall be 120 V ac.

3.2.25 Ultrasonic Position Transmitter.

Instrument Category: Miscellaneous

Instrument Type: Ultrasonic Position Transmitter

Power Supply: 120 V ac, 60 Hz

Signal Input: N/A

Signal Output: 4-20 mA

Process Connection: N/A

Classification: NEMA 4X

Description: Provide ultrasonic position system to include ultrasonic transducer, transmitter, and target. The transducer shall contain integral temperature compensation, and be constructed seamless Tefzel material. Ambient operating temperature range shall be -40°F to 160°F. Allowable separation, transducer to transmitter, shall be at least 1200 feet.

Transmitter shall have a front panel digital display of operating parameters and process conditions in operator selectable units. Programming and

	calibration shall be by way of a removable, magnetically mounted, infrared coupled, handheld programmer.
	Target shall be field fabricated design using a metal plate capable of withstanding a harsh corrosive environment.
Manufacturer:	Milltronics HydroRanger, with STH transducer.
Special Requirements:	The Contractor shall provide units capable of interchange with other ultrasonic applications. The Contractor is responsible for fabrication and placement of targets, to ensure an accurate representative signal.

3.2.26 Rain Gauge.

Instrument Category:	Miscellaneous
Instrument Type:	Rain Gauge
Power Supply:	24 V dc
Signal Input:	N/A
Signal Output:	Pulse
Process Connection:	N/A
Classification:	N/A
Description:	Provide Tipping Bucket Type Rain Gauge that tips every 0.01 inch of accumulated precipitation. The rain gauge shall be heated to enable snowfall measurement at temperatures down to 0°F.
Manufacturer:	Met One, Inc. or approved equal
Special Requirements:	The Contractor shall determine optimum conditions for placement of rain gauge to ensure accurate measurement of rain data.

3.2.27 Signal Converter-Isolator.

Instrument Category:	Miscellaneous

Instrument Type:	Signal Converter-Isolator
Power Supply:	120/208/240 V ac 60 Hz (24 V ac optional)
Signal Input:	Choice of current or voltage
Signal Output:	Choice of current or voltage
Process Connection:	Screw terminals with access holes for testing with meter probes with cover in place
Classification:	N/A
Description:	Process signal converter-isolator with the capability to select inputs and outputs. The input or output signals may be the same signal where isolation is desired or different signals where signal conversion is required. Combinations of inputs/outputs 0-1, 0-5, 1-5, 0-20, 4-20 mA and 0-1, 0-5, 0-10, 0-15 volts. Input/Output isolation 1500 VRMS AC or DC. Linearity ±025 percent. Ambient temperature range 35-140°F (12°C to 60°C). Fused input and output protection. Common mode rejection greater than 120 dB at 60 Hz.
Manufacturer:	Love Control Corporation Model 116, or approved equal.
Special Requirements:	Surface or Snap Track (2.75 inch) mounting.

3.2.28 Position Transducer/Transmitter.

Instrument Category:	Miscellaneous
Instrument Type:	Position Transducer/Transmitter
Power Supply:	25 Volts Max ac or dc
Signal Input:	N/A
Signal Output:	4-20 mA Proportional to Cable Travel
Process Connection:	N/A
Classification:	NEMA 4

Description:	Displacement transducer for measuring linear travel of an object by means of a direct connected stainless steel cable. Resolution 0.008 percent F.S. max. (10 inch [25.4 cm] or greater travel), accuracy $\underline{+}$10 percent F.S. typical for 20 inches (50.8 cm) or greater. Sensitivity based on measurement range. Operating temperature range -20°F to 125°F (-29°C to 50.7°C) minimum. Model PT801 to be used where effective range is less than 150 inches and full exposure is required. Model PT420 may be used if protected to prevent exposure to temperatures of less than 0°F (-17.8°C) or if linear travel greater than 150 inches (381 cm) is required.
Manufacturer:	Celesco Transducer Products, Inc., or approved equal.
Special Requirements:	This instrument is part of a fabricated assembly for detecting sluice gate position and transmitting a proportional position signal (4-20 mA). Fabrication of associated equipment is responsibility of the Contractor.

3.2.29 Signal Conditioner (Summation).

Instrument Category:	Miscellaneous
Instrument Type:	Signal Conditioner (Summation)
Power Supply:	24 V dc
Signal Input:	4-20 mA
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	NEMA 4
Description:	Signal conditioner shall accept at least three Analog inputs and provide the linear sum of all inputs. Unit shall have front panel zero and span adjustment ambient operating temperature range -20°F to 180°F (-29°C to 82.3°C).

Manufacturer:	Moore Industries, Wilkerson Instruments, or approved equal.
Special Requirements:	N/A

3.2.30 Signal Conditioner (P/I).

Instrument Category:	Miscellaneous
Instrument Type:	Signal Conditioner - P/I
Power Supply:	24 V dc
Signal Input:	3-15 psi
Signal Output:	4-20 mA
Process Connection:	N/A
Classification:	NEMA 4
Description:	Signal conditioner shall accept standard Pneumatic 3 to 15 psi (0.21 to 1.05 kg/cm^2) signal and convert to a linear 4-20 mA process signal with linearity error $\leq$0.05 percent, hysteresis $\leq$0.1 percent, overload protection to at least 25 psi. Signal conditioner shall be standard DIN rail mount. Ambient operating temperature range -4°F to +140°F (-20°C to 60°C) 369and relative humidity range 0 percent to 90 percent noncondensing.
Manufacturer:	VDO Instruments, Moore Instruments Rochester Instruments (RIS) or approved equal.
Special Requirements:	N/A

End of Section

SECTION 17600

PANELS, CONSOLES, AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE. This section covers furnishing free standing vertical panels for instruments and controls and for PLCs, filter consoles, wall mounted cabinets, control system consoles and enclosures for computer hardware and building monitoring equipment, and printer stands as indicated on the drawings and as required.

1.1.01 Control System. Master Specification Section 17500, Instrumentation General Requirements, shall apply to all equipment furnished under this section.

1.2 GENERAL. Equipment furnished and installed under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.01 General Equipment Requirements. When required, the General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.02 Drawings. General dimensions and arrangements are indicated on the drawings. Contractor shall be responsible for coordinating the console and enclosure sizes and arrangements to accommodate the equipment provided.

1.3 SUBMITTALS. Submittals shall be as required in Master Specification Section 01080, Project Submittals.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as required.

PART 2 - PRODUCTS

2.1 PANEL DESIGN AND FABRICATION FEATURES. All panels furnished shall conform to the requirements of NEMA ICS-6-1988. Unless indicated otherwise on the drawings, the following paragraphs describe general fabrication requirements for the PLC cabinets, instrument panels, consoles, enclosures, and subpanels.

2.1.01 Piping. Pneumatic tubing shall be 1/4 inch (63.5 cm) OD, soft annealed copper with compression fittings. Tubing and fittings shall be as specified in Master Specification Section 15020, Miscellaneous Piping and Accessories - Construction.

2.1.02 Fittings. Compression type bulkhead fittings shall be provided near the bottom or the top of the panel for all field connections. Compression nuts and sleeves shall be provided for the field connections. Indicators, recorders, controllers, and other pneumatic devices shall be provided with plugged test connections and shutoff valves for isolation.

2.1.03 Valves. All devices shall have separate air supply shutoff valves. Valves and compression fittings shall be as manufactured by Nupro, Parker Hannifin, Swagelock, Tylok, or Whitey.

2.1.04 Instrument Wiring. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. Annunciator and indicating light circuits shall be minimum 16 AWG. Electronic analog circuits shall be 16 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits.

2.1.05 Power Entrance. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts ac with a nominal clamping voltage of 200 volts. Surge protectors shall be of a nonfaulting and noninterrupting design, with a response time of not more than 5 nanoseconds. Surge protectors shall be Innovative Technology "SP-120V", Power Integrity Corporation "ZTAS", or Transtector "ACP 100 BW".

2.1.06 Power Wiring. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring and wiring for control circuits shall be minimum 14 AWG. Wiring for ac power distribution, dc power distribution, and control circuits shall have different colors and shall agree with the color-coding legend on Contractor's panel wiring diagrams. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame retardant covering rated for not less than 195°F (90°C).

2.1.07 Terminal Blocks. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Not less than 8 inches (20.5 cm) of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

2.1.08 Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the instrument device schedules and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered labels or tape labels will not be permitted.

2.1.09 Nameplates. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends, as indicated on the drawings, and shall have black baked enamel letters on anodized aluminum plate. Letters shall be 3/16 inch (5mm) high. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified under the Device Tag Numbering System paragraph.

2.1.10 Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust inhibitive (universal) primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils (100 mm). Color samples shall be submitted to Engineer for color selection. One quart (1 liter) of paint shall be furnished with the panels for future touchup painting.

2.1.11 Factory Test. Panels shall be factory tested electrically and pneumatically by the panel fabricator before shipment.

2.2 FREESTANDING VERTICAL PANELS. The following paragraphs describe specific requirements for the freestanding vertical panels:

2.2.01 Construction. Panel construction shall be an indoor, dusttight, completely enclosed cubicle formed from steel structural members and steel plates. The base shall be formed of steel channels, with flanges extending upwards. The base shall be provided with 1/2 inch (12.5 mm) diameter holes at 12 inch (300 mm) centers so that the base can be bolted to the concrete equipment base. Welds, seams, and edges on all exposed surfaces shall be ground smooth. Suitable lifting facilities shall be provided for handling and shipment.

2.2.02 Structure. Panel structure shall be suitably braced and of sufficient strength to support all equipment mounted on or within, to withstand handling and shipment, to remain in proper alignment, and to be rigid and freestanding. Top, sides, and back shall be fabricated from USS 10 gage (3.42 mm) thick or heavier carbon steel sheets, with stationary back suitable for back to wall installation, or designed for rear access with hinged back doors as required. Doors shall not be greater than 24 inches (610 mm) wide or spaced not greater than 36 inches (915 mm) center to center as required. Rear access doors shall be fabricated from USS 14 gage (1.9 mm) thick or heavier carbon steel.

2.2.03 Panel Front. When required, the front shall be a hinged door, or doors, with mounted instruments and control devices, fabricated from USS 10 gage (3.42 mm thick) carbon steel sheet and suitably braced and supported to maintain alignment. Panels with hinged fronts shall be of sufficient width to permit door opening without interference with rear projection of flush mounted instruments.

2.2.04 Doors. Doors shall be essentially full height, having turned back edges and additional bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a common door handle, shall hold doors securely compressed at top, side, and bottom against rubber gaskets. Door keys shall be Master 2246.

2.2.05 Mounted Instruments. When required, the front shall be stationary, with mounted instruments and control devices, fabricated from 3/16 inch carbon steel plate. Panel fronts shall be suitably reinforced between mounting cutouts and drilling to support instruments and devices without deformation and shall be free from waves and other imperfections. When required, panel fronts shall be recessed at the base. Adjoining panel sections shall be accurately shop fitted to assure satisfactory assembly in the field.

2.2.06 Instrument Arrangement. Panel instruments and control devices shall be arranged in a logical configuration for the plant operators. The centerline of recorders shall be within 3 feet (0.9 m) and 5'-9" (1.75 m) above the base of the panel for convenient reading and chart replacement. Control switches shall be within 6 feet (1.83 m) and 2'-6" (0.25 m) above the base of the panel. Indicators may be located within 2'-6" (0.75 m) and 6'-6" (2 m) above the base of the panels. Annunciators and clocks may be mounted near the top of the panels.

2.2.07 Conduit Entrance. When required, the bottom shall be open, and components shall be arranged for external wiring conduit and piping to enter from below. When required, the top shall be provided with nominal 1 square foot (0.09 m^2) removable access plates, which may be drilled to accommodate external wiring and conduit to be installed from above.

2.2.08 Size and Arrangement. Panel dimensions and general instrument arrangement shall be as indicated on the drawings.

2.2.09 Interior Lighting. Illumination of panel interiors shall be provided by ceiling mounted lamp fixtures spaced at approximately 2'-6" (0.75 m) and near the door. Fixtures shall be 100 watt, incandescent or fluorescent tube type, with a common "On-Off" switch near each end door. Duplex-GFIC receptacles shall be provided for service and maintenance tools at spacing not greater than 5 feet (1.5 m) throughout the length of a panel. The lighting and receptacle circuit shall be fused separately from the instrumentation systems.

2.3 FILTER CONSOLES. The following paragraphs describe specific requirements for the filter consoles:

2.3.01 Construction. When required, each filter console shall be fabricated from structural steel members and USS 10 gage (3.42 mm) thick carbon steel sheet to provide a rigid and freestanding structure of sufficient strength to support all equipment, withstand handling and shipment, and maintain alignment. All exposed welds, seams, or edges shall be ground smooth. Edges shall be slightly rounded.

When required, fiberglass reinforced plastic filter consoles will also be acceptable. Consoles shall be constructed from fiberglass reinforced polyester resin laminate having a tensile strength of at least 15,000 psi (107,000 KN/m^2). Dimensions, access, and wiring shall be the same as specified herein for the steel filter consoles.

Fiberglass console wall thickness shall be at least 1/8 inch (3 mm), with instrument mounting surface thickness not less than 1/4 inch. Console bodies shall be laminated and bonded to form a one-piece unit requiring no metal strips to form mechanical seams. There shall be no exposed glass fibers. Consoles shall be painted or fabricated using pigmented resin.

2.3.02 Mounting. Consoles shall be designed for mounting directly on the filter operating floor, or on a raised concrete curb when required, with conduit entrance through a floor slab opening under the console. Consoles shall be provided with heavy channel iron bases, flanges up, so that they may be anchored to the floor.

2.3.03 Access Panels. Consoles shall have removable front access panels with flush mounted latches. Hinged rear access doors shall be provided. Latches and panel fasteners shall be easily operated by hand without the use of a screwdriver or other tool. Latches and other hardware shall be chromium-plated or stainless steel. The consoles shall be completely shop assembled, and shipped as complete units. Access panels may be fabricated from USS 14 gage (1.9 mm thick) or heavier carbon steel. Access panels shall be gasketed.

2.3.04 Size and Arrangement. Nominal console dimensions and device arrangements are indicated on the drawings. Installed console height shall not exceed 54 inches (1.35 m) from the operating floor or as required. A separately fused duplex receptacle shall be provided in each filter console for service and maintenance tools.

2.3.05 Grounding. An electrical ground conductor shall be connected to all instruments in fiberglass consoles.

2.4 WALL-MOUNTED CABINETS. Cabinets, which contain the system components indicated on the drawings, shall be NEMA Type 12, 3R, 4, or 4X enclosures as required, suitable for wall mounting. The enclosures shall be fabricated from USS 14 gage (1.9 mm) thick, or heavier, carbon steel, stainless steel, or fiberglass as required. Cabinets shall be equipped with full size gasketed doors with hinges and a chromium-plated or stainless steel three-point latch. A screened vent shall be provided in the bottom of enclosures that contain pneumatic devices.

All wall-mounted cabinets shall meet the requirements of the panel fabrication paragraph of this section.

Outdoor cabinets shall be provided with sunshades as indicated on the drawings and as required.

2.5 WALL MOUNTED INSTRUMENT SUBPANELS. Instrument subpanels shall be constructed from 1/8 inch (3 mm) thick carbon steel and shall be reinforced and braced as required to form a rigid assembly. Panels designed for wall mounting shall have 1 inch (25 mm) turned back edges and a minimum 2 inch (50 mm) air space between the panel and the wall surface. All components on wall-mounted panels shall be mounted so as to be easily removable without requiring rear access to the subpanel.

2.6 CONTROL SYSTEM CONSOLES AND ENCLOSURES. A main control system console, printer enclosures, and printer stands shall be provided as indicated on the drawings and as required.

2.6.01 Control System Console. The control system console shall be a modular system consisting of straight, angular, and corner sections to provide an arrangement as indicated on the drawings. Console sub-structure shall consist of a welded steel frame and extruded aluminum horizontal supports. Structural arrangement shall allow connection of modular sections to produce a seamless equipment mounting enclosure.

2.6.02 Internal Wiring. Integral wireways and surge-protected receptacles shall be provided throughout the console structure. Contractor shall coordinate the receptacle spacing and number to ensure adequate power connections are available for the equipment to be located in the console. When required, Contractor shall coordinate with the CCTV, Security, Intercom, and Radio Suppliers and install receptacles as required for powering the associated equipment.

2.6.03 Equipment Mounting. Equipment mounting kits shall be provided to support the equipment items to be located in the console. This shall include, but not be limited to, operator CRTs, operator workstation computers, workstation servers, historical/data collection components, and printers. When required, kits shall be provided for closed circuit television (CCTV) equipment, security equipment, intercom equipment, and radio equipment. CRT support shelves shall be adjustable to allow CRTs of various sizes to be centered in the front panel. Central processing unit (CPU) support shelves shall be of the fixed or slideout type as required.

2.6.04 Exterior Panels. Console exterior panels shall be attached to the console structure with concealed hardware and shall be removable without the need for tools. Where indicated on the drawings, hinged access panels shall be provided. Exterior panels shall be constructed of rift cut domestic red oak veneer over composite core, plastic laminate over composite core or formed, painted metal as required.

2.6.05 Work Surface. Work surface shall be 1 inch core, with high-pressure laminate surface and backing. Work surface nosing and edge shall be solid oak, finished to match the exterior panels or shall be soft urethane with plastic laminate edges. Base trim shall be high-pressure laminate over composite core to match work surface.

2.6.06 Console Front. When required, the front surfaces of the console shall be wood veneer or plastic laminate over composite core; or shall be formed, painted metal; with window cutout sized to accommodate the CRTs provided. Hinged, glare control glass and shall be provided for access to the CRT. Continuous task lighting shall be provided along the length of the CRT mounting area valance or retractable task lights shall be provided on each end section of the console as required.

2.6.07 Color Samples. Contractor shall submit color samples for all exterior panel, work surface, equipment front, and edge surfaces to Engineer for color selection.

2.6.08 Manufacturers. The console shall be Evans Consoles, "Series 200" or Tresco.

2.6.09 Printer Enclosures. When required, printer enclosures shall be of a noise buffering type, furnished in the quantities indicated on the drawings. The printer enclosure shall be of the same general construction and finish as the control system console. The enclosure shall be provided with a hinged glass cover with pneumatic supports to hold the cover in the raised position. The enclosure shall have a support shelf with paper access slot as required for the printer provided. Under shelf storage space shall be sufficient to store a standard carton of 11x14 inch computer paper. The paper storage area shall be accessible through hinged access doors on the enclosure front.

2.6.10 Printer Stands. When required, the printer stand shall be an open shelf design, sized to support the report printer provided. The stand shall be provided with shelved storage space under the printer-mounting surface. Access to the storage space will be through lockable doors. The cabinet shall be constructed of materials to match the control system console exterior panels. Printer mounting surface height shall be approximately the same as the work surface of the control console. The printer stand shall be provided by the control console manufacturer.

2.7 CONTROL SYSTEM FURNITURE. When required a main control system desk, a control system desk, printer enclosure(s), a printer stand(s) shall be provided as indicated on the drawings.

2.7.01 Control System Desk. The control system desk shall be a freestanding desk-based system consisting of linked work surfaces on pedestals in the general arrangement indicated on the drawings. Contractor shall coordinate the types and quantities of console components required, and shall furnish and install all additional components, including supports and connecting brackets.

2.7.02 Work Surfaces. Work surfaces shall of be high-pressure plastic laminate over a high-density wood composite and shall be 1-1/4 inches (32 mm) thick, 30 inches (760 mm) wide, and of the length required. Special corner work surfaces shall be provided where required. Back panels at least 19 inches (480 mm) high shall be provided for all work surfaces. Work surface dimensions shall be coordinated with the pedestals to ensure proper stability and access to wireways. Where indicated on the drawings, work surfaces shall be provided with hinged corner access channels for wire and cables.

2.7.03 Pedestals. Pedestals shall be provided as indicated on the drawings or as required to support the work surface arrangement. Pedestals shall be of painted steel, with integral, double-walled desk drawers.

2.7.04 Internal Wiring. The console shall be provided with a concealed wireway system, mounted near the back edge of the work surface and accessible from the console back without the use of special tools. An integral power raceway system shall be provided to distribute power to the control system components. The power system shall consist of sufficient receptacles and wiring to accommodate the control system components and task lighting.

2.7.05 Task Lighting. Task lighting for work surfaces shall be installed along the back panels. Lighting shall consist of continuous track lighting or articulating lamps mounted on brackets.

2.7.06 CPU Mounting. When required mounting kits shall be provided for installing CPUs under the work surfaces. The numbers and locations of the CPUs are indicated on the drawings.

2.7.07 Color Samples. Contractor shall submit color samples for all work surfaces, back panels, and pedestals to the Engineer for color selection.

2.7.08 Manufacturers. The console shall be Allsteel "Syntrax II" or equal.

2.7.09 Printer Stands. The printer stand shall be of open shelf design, with lockable doors, sized to support the report, alarm, or color printer furnished, and with shelved storage space under the mounting surface. The control console manufacturer shall provide the printer stand.

2.7.10 Cabinet. The cabinet shall be constructed of materials to match the control system console exterior panels. Printer mounting surface shall be of approximately the same height as the work surface of the control console.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS. Installation requirements are specified in Master Specification Section 17500, Instrumentation General Requirements. In addition, equipment furnished under this section shall conform to the following manufacturing requirements.

3.1.01 Piping. All tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipment. Flexible polyethylene tubing shall be used to connect devices mounted on hinged doors.

3.1.02 Wiring. All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and bound by nylon cable ties or shall be routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

3.1.03 More Than One Panel. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.

End of Section

SECTION 17700

UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SCOPE. This section covers the furnishing of a complete on-line uninterruptible power supply (UPS) for The Computer Control System as indicated on the drawings and as required.

The system shall convert incoming single phase, 60 Hz, power into dc power, maintain and charge backup batteries and reconvert outgoing power into a sinusoidal single phase, 60 Hz, ac power source. The system shall consist of a rectifier, battery charger, batteries, inverter, and integral static bypass switch. When required, a maintenance bypass switch shall be provided such that UPS can be disconnected from power and maintenance can be performed.

Additional accessories and appurtenances shall be provided as specified herein and as required to provide a complete and properly operating system.

1.1.01 Control System. Master Specification Section 17500, Instrumentation General Requirements, shall apply to all equipment furnished under this section.

1.1.02 Control System Loads. The UPS shall supply Control System and other loads located in or external to the control room as shown on the drawings or as listed herein.

1.2 GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1.2.02 General Equipment Requirements. When required, the General Equipment Stipulations in Master Specification Section 01180, Equipment, Materials, Parts, and Tools shall apply to all equipment provided under this section.

1.2.03 Drawings. Supplementing this section, the drawings indicate locations and arrangement of enclosures and provide one-line diagrams regarding the connection and interaction with other equipment.

1.2.04 Nameplates. Each UPS shall be identified with a suitable engraved nameplate mounted on the top front and when required, a nameplate shall also be provided for each of the external manual bypass switches. Nameplates shall have black baked enamel letters on anodized aluminum plate. The lettering shall be bold, not less than 1/4 inch [6 mm] square.

1.3 SUBMITTALS. In addition to the requirements of Master Specification Section 17500, Instrumentation General Requirements, all material and equipment documentation shall be submitted for review in accordance with Master Specification Section 01080, Project Submittals. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

Equipment and materials descriptive literature and drawings shall show the specification paragraph for which equipment applies.

Sheets or drawings showing items not applicable to this system, or not requiring review, shall contain clear indication as to which section or sections require review.

Functional line diagrams showing all major system components and external connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

A report certifying that the UPS will provide the required backup time at the specified UPS loading and UPS ambient temperature. The report shall include anticipated continuous electrical load calculations, backup time calculations and shall indicate the battery end-voltage used in the analysis.

1.4 DELIVERY, STORAGE, AND SHIPPING. Delivery, storage and shipping shall be in accordance with the requirements of Master Specification Section 01180, Equipment, Materials, Parts, and Tools.

1.5 SPARE PARTS. Spare parts shall be provided as required.

PART 2 - PRODUCTS

2.1 GENERAL. All equipment, enclosures, and accessories shall be designed, assembled and connected in accordance with the requirements of these specifications and the drawings.

2.1.01 System Design Requirements. The UPS system shall conform to the following standards and features and other features as required:

Capacity	__._KW
Capacity, peak (minimum)	150 percent of continuous

	power rating for 10 seconds.
Frequency stability, battery mode	±0.5 percent.
Harmonic distortion (max)	5 percent.
Efficiency, overall on-line	75 percent minimum.
Operating temperature-humidity	32°F to 104°F (0°C to 40°C) 0 to 95 percent relative humidity, non-condensing.
Recharge time (max)	4 hours.
Input Voltage at 60Hz +10 – 15 percent	120 240 120/240
Output Voltage at 60Hz AC	120 120/240

2.1.02 Acceptable Manufacturers. All systems supplied under this contract shall be of the same manufacturer. The uninterruptible power supply systems shall be MGE EXL series, Powerware 9170 series, APC Symmetra, or equal.

2.1.03 Terminal Blocks. Wiring for external circuits, including all alarm contacts, shall be brought to grouped terminal blocks located for convenient connection. Provisions shall include suitable marked terminal blocks for connection of No. 12 AWG control wiring and for input/output power conductors as sized on the drawings. Terminal designations shall agree with manufacturer's wiring diagram.

2.2 BATTERY CHARGER/RECTIFIER AND BATTERIES. The battery charger and the rectifier shall have the following characteristics:

The rectifier shall convert the incoming ac power to dc power to energize the static inverter.

The battery charger shall supply a float current to the batteries to maintain them at a fully charged state while incoming power is being provided. The charging voltage shall be temperature-compensated over the entire operating temperature range to avoid overcharging or undercharging the batteries. The battery charger shall automatically apply an elevated voltage (equalization charge) to the batteries if and as required by the battery manufacturer.

The batteries shall provide backup power for the UPS when incoming commercial power is not available. The batteries shall be valve-regulated or gelled-electrolyte lead-acid type. The batteries shall be integral to the UPS; or may be externally mounted when required. Batteries shall have capacity to supply the dc power to the UPS while operating at full load for a period of not less than 4 hours at 75°F (25°C). The batteries shall have an expected life of 5 years and shall carry a one-year warranty.

2.3 STATIC INVERTER. The solid-state inverter shall employ silicon-controlled rectifiers (SCRs) and other devices for converting direct current power to essentially sinusoidal alternating current power. The static inverter shall conform to the following characteristics and requirements.

Automatic Synchronization: During normal operation, the inverter shall provide power to critical loads. The utility electric system will act as an alternate supply. Inverter equipment shall include stable solid-state devices designed to automatically maintain inverter output in phase with the utility electric system.

Overload, Short Circuit, and Load Loss: The inverter shall have input and output fuses and other equipment necessary to protect from overload, short circuit, and 100 percent loss of load. Current limiting features shall also be provided.

Loss of Supply Voltages: The inverter shall include protective devices to prevent damage resulting from excursion, loss, or restoration of its synchronization voltage and its dc input voltage and any inrush current occurrences associated with such conditions.

2.4 STATIC TRANSFER SWITCH. When required, the static transfer switch shall use SCRs and other static devices required to automatically transfer loads from the off-line (bypass) to the on-line operating condition and back again. In off-line mode, the static transfer switch shall connect clean filtered power to the load. The primary ac line shall be monitored and the load shall be transferred to the inverter if the voltage drops below 85 percent. During on-line mode operation, any inverter problem shall cause an instantaneous transfer to the bypass mode.

2.5 MAINTENANCE BYPASS SWITCH. When required, a maintenance bypass switch shall be provided so maintenance can be performed on the UPS without disrupting control system operation. The bypass switch shall be independent of the UPS electronics.

2.6 OUTPUT RECEPTACLE PANEL. An output receptacle panel with a variety of NEMA 5, 6, L5, and/or L6 receptacles shall be furnished on the rear of the UPS. The SYSTEM SUPPLIER shall coordinate the size, number, and type of the receptacles with the equipment as required or as indicated on the drawings.

2.7 CONTROL, INDICATION AND ALARM. Controls, indicators and alarms shall be provided as a part of the UPS. Control buttons and LED indicators shall be provided on the UPS panel and shall be permanently labeled.

2.7.01 Controls. A dc battery circuit breaker, a mode selector switch, and system "ON" and "OFF" buttons shall be provided.

2.7.02 Indication. A digital display for selection and indication of input, output, and battery voltages shall be provided.

LED indicators for inverter ready, frequency, battery voltage, overload, over temperature, and impending shutdown conditions shall be provided.

When required, LED indicators for bypass ready, bypass mode, and on-line mode shall be provided.

2.7.03 Remote Alarms. The UPS shall have the following provisions for remote alarms.

2.7.04 General Alarm. A common, isolated, dry, alarm contact rated 3 amperes at 120 volts ac shall be provided with the UPS for indication of general alarm. The contact shall close under any UPS fault condition.

2.7.05 Power Failure. An isolated, dry, alarm contact rated 3 amperes at 120 volts ac shall be provided with the UPS for remote indication of power failure. The contact shall open upon loss of commercial power to the UPS.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS. Installation requirements are specified in Master Specification Section 17500, Instrumentation General Requirements.

3.2 OWNER TRAINING. Contractor shall provide a qualified representative at the jobsite to train Owner's personnel in operating, maintaining, and repairing the equipment. The training shall consist of one full 4 hour session and the schedule shall be arranged and coordinated with Owner.

End of Section